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Discussion of
"MOVEMENTS IN STRUCTURAL CONCRETE AT CONOWINGO HYDRO PLANT"

by Stanley Moyer and Viggo Hansen
(Proc. Sep. 308)

STANLEY MOYER[1] and VIGGO HANSEN,[2] Members, ASCE.—One year has elapsed between presentation of the paper and the closure. A visual inspection after the increase in leakage late in November revealed no definite trend. The first complete survey of the building monuments since the paper was presented was made in January, 1955, as per the schedule given in the paper.

Mr. H. A. Kammer had experience with the growth of concrete at the Buck Hydro Plant that they considered was due to the reactive course aggregate, wet concrete and the probability of high alkali cement. The writers also are hopeful that solution of their company's problems will not require the serious corrective measures that they were compelled to make. The writers were apparently fortunate in changing to off the site aggregate after the first 62,000 yds. (out of 236,000).

Figure No. 1 showing cross-section of the Power house has the area where the local stone concrete was placed indicated by cross hatching at the lower right hand corner. This information was not clear in the written paper. The survey line referred to in the paper as "on elevation 80 in the headworks wall," can be seen to be close to the upriver part of Power house and it was decided that no line further north could be accurately surveyed.

Observations indicate the short cycle of daily temperature change only affects the south wall (downriver) as most of the concrete is not subjected to appreciable daily changes of temperature but is affected by the change in water temperature, which roughly resembles the sine curve with the year as one complete cycle.

The concrete roof of the turbine hall is supported on steel trusses and purlins and therefore that concrete would not affect the overall dimensions and no difficulty has been experienced in the roof structure except some maintenance at the two expansion joints.

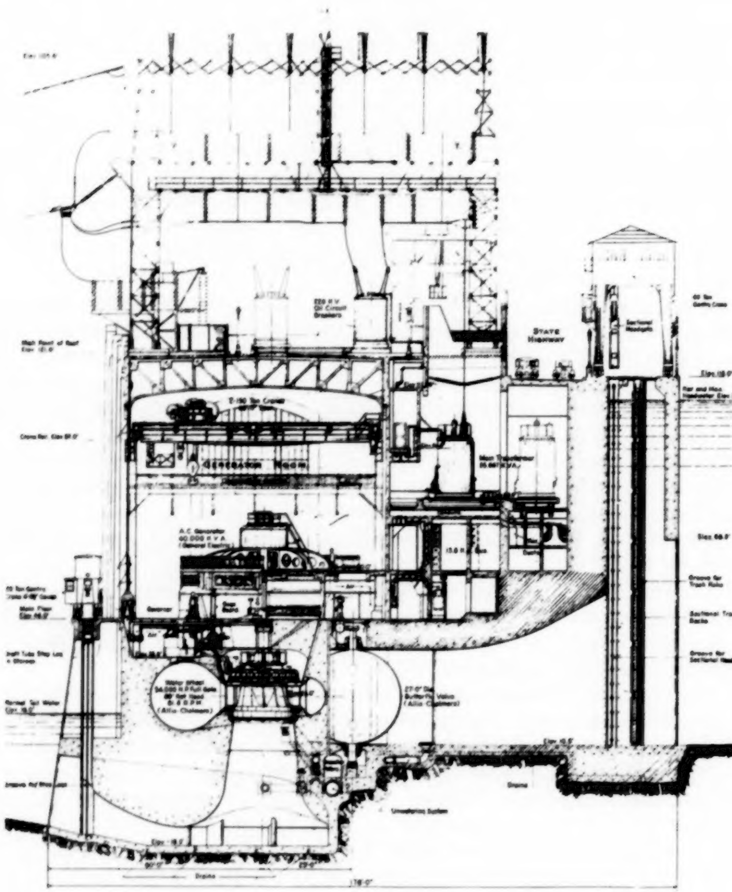
The only observed leakage at the Plant has been in the area where the local aggregate was used, namely below elevation 46. This area is subjected to the full change in water temperature and is vulnerable to the effect of water being applied to the questionable materials as well as carrying the silt into that portion of the Power house. The headworks section above the intake has shown no particular distress and as noted above, no leakage has been observed above elevation 46. There has been some binding of doors in this section and a few cracks in the walls of the rooms but they do not indicate a movement of more than the quarter of an inch which was noted in the paper.

1. Asst. Mechanical Engr., Philadelphia Electric Co., Philadelphia, Pa.
2. Engr. in Charge of Structural Section, Philadelphia Electric Co., Philadelphia, Pa.

The magnitude of vertical movements has not been ignored but up to the present time no operating difficulties have developed probably due to uniform vertical movements.

Mr. E. A. Woodhead brought out the problems at the American Falls Plant and that they were also subjected to trouble caused by reactive aggregates and high alkali cement. Again the difficulties and corrective measures have been much more serious than those experienced at Conowingo. They have had the opportunity to eliminate those questionable materials as well as to use a greater percentage of reinforcing to control expansion and contraction in some of the later Plants such as the C J Strike Plant with success.

Conowingo is the only hydro plant which was designed and built for the Philadelphia Electric Company and the writers have little possibility of using past experiences in future designs.



POWER STATION
CROSS SECTION - UNIT NO. 5
THE CONOWINGO HYDRO-ELECTRIC DEVELOPMENT
THE SUSQUEHANNA POWER CO.
PHILADELPHIA ELECTRIC POWER CO.
STONE & WEBSTER INC.

Discussion of
"STATISTICAL REVIEW OF DAM CONSTRUCTION"

by Robert A. Sutherland
(Proc. Sep. 355)

E. MONTFORD FUCIK,[1] A.M. ASCE.—Mr. Sutherland is to be congratulated for the work he has done in making available, for the use of practicing engineers, data on more than 1600 dams throughout the world. The writer is sure that those who are concerned with the design of dams will refer to this tabulation many times.

Figure 4, which shows the chronological increase in the height of various types of dams, brings to mind the question as to whether engineers have at their command today adequate design data to permit them to design with confidence, dams higher than the existing dams. This question, in the writer's opinion, applies equally to concrete dams and to earth dams.

Recent studies of the stresses observed in the foundation of Shasta Dam and observation of the actions of Norris Dam and Fontana Dam indicate that the assumptions normally used for determining the stress distribution along the foundation of a concrete dam are considerably at variance with conditions as they actually exist. It has been observed at Fontana Dam that the joints on the downstream face normal to the line of greatest thrust, open during cold weather and close during warm weather. It is obvious that during the periods during which these joints are actually open, no stress is carried across them and, therefore, it can be concluded that the outer shell of the dam is carrying no load to the foundation. The effect of temperature stress, during the setting of the concrete, apparently causes the heel and toe to curl up, thus causing the foundation stresses to be considerably different than the usually assumed straight line triangular pressure variation from heel to toe.

It would appear that, if engineers are to be called upon to design higher and higher dams, as would seem to be indicated by the trend of the data presented by Mr. Sutherland, considerable research will be required in order for them to design these dams with maximum economy. Possibly it will be found that the upstream batter of a gravity dam should be increased, whereas the downstream face of the dam might possibly be steepened. In any event, consideration of dams higher than those already built certainly brings up problems for which there is no clear solution at the present time.

In the field of earth dams, a somewhat similar condition exists in connection with the evaluation of the internal pore pressures which have been observed to exist in the impervious sections of some of the larger dams. When studying the stability of an earth dam, say 400 - 500 feet high, this problem assumes great importance and satisfactory design methods of handling it are not generally available. This probably results in over-design and the writer believes that when this problem is thoroughly understood, it will be possible to make considerable economies in large earth dam design.

The tabulation of data on the dams might be more useful if an indication

1. Vice-President, Harza Eng. Co., Chicago, Ill.

were given as to what was used as the criteria of height. Upon studying this table, it would appear that the height of concrete dams has been considered as the height from the base of the dam to the crest, whereas for earth dams and rock fill dams, it appears that the height has been taken from the stream bed to the crest. This difference, although of no consequence when considering the design of the dams, would have some effect upon the statistical analysis. For instance, Parker Dam, a concrete dam, which has a gross head between headwater and tailwater of only about 75' has a height of concrete of about 320'. On the other hand, the Anderson Ranch Dam, an earth dam, which has a height above stream bed of about 330' has a large cut-off trench about 100' deep below the stream bed, which makes the total height of the earth fill more than 400'.

Again the writer wishes to thank Mr. Sutherland for the fine work he has done in assembling these data on dams.

CLAUDIO MARCELLO,[2] M. ASCE.—The tabulation developed by the author is of very great interest and value to all the engineers who are concerned with the design and construction of high dams, and the writer agrees completely with the hope that some day a "who's who" of dams may be made available to the Profession.

With the object of contributing to the aim of the author, a list of Italian dams over 100 feet high has been worked out in the same way as Tabulation I of the Paper:

It is very true that dams are often called with several names, and that this fact is very confusing: a typical example is the Campo dam (Italy) No. 312 in the list of the author's paper, which is still now regularly called also Colombera and Tartano. In the list of Italian dams appended hereto, each structure is quoted only one, under the name given by the responsible agency, recording also in brackets the alternative names which may be in use.

Actually arch dams should be divided into two classes, e.g. single-curvature and double curvature structures, the latter being "cupolas" or "domes." Anyway, to follow as closely as possible the original notations, the two classes have been grouped together as arch dams.

As to designation of the height, the same concept as adopted by the author has been maintained, insofar as the figure represents the actual structural height of the dam, that is the height upon which the stability computations are based.

No proposed dam is included in the tabulation, since it is very likely that proposed dams, before being actually completed, will undergo several changes. No estimate has been made of the time of completion of dams now under construction: in the writer's opinion it is preferable to leave the question of completion open rather than make a definite statement as for instance in the case of the San Salvatore dam (No. 1270) which never got beyond the construction of the cut-off wall, or of the Castrola dam (No. 248) construction of which was never even started.

T. M. PATTERSON,[3]—As requested, the listing of those dams which are located in Canada has been reviewed and, although this Division does not maintain accurate statistics on dams, the following comments are offered from information on hand. . . . .

2. Cons. Engr., Societa Edison, Milano, Italy.
3. Chief, Water Resources Div., Dept. of Northern Affairs and Natl. Resources, Ottawa, Canada.

Although a large number of hydro-electric developments have been completed in Canada, in most instances, the hydraulic head has been secured by taking advantage of favourable topographical conditions rather than by building high dams. It is considered that, in so far as Canada is concerned, Mr. Sutherland's list is fairly complete.

CARLO SEMENZA,[4] M. ASCE.—About the height of the dams, the writer too had often the opportunity of noticing that it is variously reported in technical literature; this is a rather serious complication from a statistical point of view, and also because it makes every comparison uncertain. Perhaps it would be advisable to mark or to underline the height mentioned in the author's review, when it is the maximum one (the maximum being the figure as stated by the author): in this way a certain comparison is possible.

R. A. SUTHERLAND,[5] M. ASCE.—The thanks of the writer are tendered to the many engineers who have so willingly furnished information which has been used to amplify and correct Table I. An acknowledgment of such assistance is indicated by the reference numbers after the names of the dams in this revision. Information in many cases was available from two or more sources, but it has not deemed necessary to obtain exact coincidence in figures of height or other dimensions which might differ by a small percentage as between the different sources, although any major differences in information have been tracked down as far as possible.

Few of the communications received were in the nature of formal discussions and portions only have been reproduced, but many of them had a comment or suggestion on specific points, amongst which were the following:

1) The height should be more exactly defined
2) Types of dam should be further subdivided
3) More information should be given
4) Proposed dams may or may not be built

The writer agrees with the desirability of the first three suggestions, but lack of time has prevented him from attempting this labor. As pointed out in the original paper, the engineering profession has been remiss in not having any accepted definitions for such things as height and type of dams, but the provision of such definitions is properly the duty of a constituted committee or other body. With regard to the inclusion of "proposed" dams in the list, the writer believes that in almost all cases, a proposal to build a dam represents a need for that dam and also represents the expenditure of time and money in making the investigations, and that the listing of proposed dams, therefore, has real value.

It is now over 18 years since the writer first published a modest compilation of dams[6] which contained about 600 entries; that compilation showed that the number of dams over 100 feet high had practically doubled each decade, and it could not be reasonably expected that such a geometric rate of increase would be maintained. Nevertheless, in spite of a period of depression and international disturbances, the number of dams has much more than doubled in the succeeding period.

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4. General Manager and Chief Engr., Hydro Construction Dept., Societa adriatica di Elettricita, Venice, Italy.
5. Civ. Engr., Ebasco Services, Inc.
6. "Dam Building reaches a Climax," Engineering News Record, December 10, 1936.

Mr. Fucik questions whether means are available to design dams of greater height than any now built, and the answer must undoubtedly be "yes." As the need for high dams, or in fact any other types of structures, becomes sufficiently great, means will be found to fill that need. An open mind on the part of the designers is a first essential, for it may well be that a totally different approach to the problem becomes in order for great heights of dam. There are probably some few sites suitable for arch dams of 1000 feet or more in height, but a reappraisal of the proper shape or real factor of safety of high gravity dams may lead to a changed viewpoint as to the economic value of this type for great heights. There are no indications that the rockfill or earth fill type will ever approach 1000 feet in height.

The summary tables III through IX show the effect of the more complete listing than was given in the original paper, but the qualitative conclusions are not greatly altered. Table X has been expanded to show the division of the built and proposed dams in the different countries into different types. It is seen that some countries have favored a predominant type, either for historical or other reasons, while other countries have a reasonable diversity of type. The United States and Mexico are the only countries of any size where earth dams outnumber gravity dams. In the case of the United States, this has been true for many years.

Addendum to Tables I through X

NOTES TO TABLE I ADDENDUM.–

8D The Aiba dam was built in Italy in territory which was transferred to Yugoslavia in 1947.

76 The Baker R dam is also known as Shannon dam.

137 The Bionia dam was built in Italy in territory which was transferred to France in 1947.

223 A second dam of earth fill forming the Campotosto storage will be over 100 ft. high when raised in a later stage.

227A It is proposed to raise the Saint Chamond dam to 187 feet height.

346 The Cruz del Eje dam consists of 2822 feet length buttress dam
6561 feet length earth dam
526 feet length rock fill dam
196 feet length gravity spillway

365 Davis Bridge dam is also known as the Harriman Dam.

372 The foundation of the Denison dam is predominantly shale with some limestone and sandstone.

385 The Dixence Dam will be submerged by the Grand Dixence dam. (see No. 548)

421 The data given for Eildon dam is for an enlargement of a previous dam built in 1927.

453B The Fergoug Dam (denoted wrongly as Habra in the original list) was originally 115 feet high but has failed twice and has been only partially rebuilt to a height of 77 feet.

463 Folsom dam has also an earth fill structure called Mormon Island Auxiliary Dam, 110 feet high and 4820 feet long.

548 At planned rate of construction the second stage of the Grand Dixence dam is so far in the future that it has been denoted as "proposed."

549C The Grands Cheurfas dam according to one authority is only 95 feet high; according to another was raised in 1936 to 131 feet.

669 The Jordan dam was strengthened with buttresses about 1951.

757A The Lac Casse dam also comprises a second dam 200 feet high and 1000 feet long on the adjoining Desroches River.

773F Lago Verde dam was strengthened in 1927 by adding 6900 cubic yards of dry masonry upstream.

816A The Licq Athery dam was built in 1917 as a gravity dam 105 feet high and raised in 1953 by an arch addition.

944 A saddle dam associated with the Molare dam failed in 1935.

1016 The dam originally called Non was renamed Santa Giustina.

1110A The Name of the Pena dam which was built in 1913 has a "tilde" over the letter "n."

1137 The original structure at Ponte Alto was of timber and built in 1537.

1136A The Pont du Loup dam was drowned out by the Sautet Dam in 1934.

1196B The Rio Fucino dam will be raised in a later stage.

1252 The San Domenico dam has in addition a cut-off wall 125 feet deep.

1269 The San Roque dam replaces a previous gravity dam 114 feet high built in 1931.

1351B The Sottosella dam was built in Italian territory which was transferred to Yugoslavia in 1947.

1425 The Tansa dam was strengthened by post tensioned cables in 1954.

1435 The Tennessee Creek dam comprises also a second dam of rock fill 140 feet high, 385 feet long, 150,000 cubic yards on an arkose schist found.

1443A The Thorpe dam also contains an earth and rockfill saddle dam 122 feet high, 410 feet long, with 232,000 cubic yards fill. The name was changed from Glenville to Thorpe in 1950.

1549 The Wainganga dam has also 17 miles of dike.

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Note: The reference numbers are placed immediately following the names of the dams.

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1A	Aberdeen Upper 28	Aberdeen		Hong Kong	138G	400	28 400	637		1931
2	Abitibi Canyon 15	Abitibi	Ontario	Canada	290G	840	299 000	11 200	Gabbro	1933
3	Adaminaby 47	Eucumbene	N.S.W.	Australia	390ERF			3 860 000		Proposed
5	Agaro 25 - 9	Agaro	Piemonte	Italy	170G	800	195 000	16 300	Granite Gneiss	1940
8	Aguasabon 15	Aguasabon	Ontario	Canada	110G	1 340	82 500	49 400	Granite	1948
8A	Agueda 11 - 30 - 34	Agueda	Salamanca	Spain	108G	607	49 000	20 700		1931
8B	Aguilar 11	Pisuerga		Spain	132G		285 000	186 500	Limestone	Under Const.
8C	Agujere 11 - 30 - 34	Guadalmedina	Malaga	Spain	108G			4 100		1928
8D	Alba 25	Isonzo		Yugoslavia	102G	229	17 000	1 300	Marly Limestone	1940
9	Aigle see L'Aigle 5 - 33									
9A	Ait Ouarda 3 - 7 - 16A	Oued el Abid	Casablanca	Morocco	148A	395	33 000	3 100	Limestone	1953
10	Aiyar 1	Damodar		India	220E	23 000		1 250 000		Proposed
13	Akiba No. 1 29	Tenryu	Tokai	Japan	273G	886	536 000	28 000	Schist	1956
14	Akiba No. 2 29	Tenryu	Tokai	Japan	181G	975	520 000	6 100	Schist	1957
16A	Alarcon 11 - 30 - 34	Jucar	Cuenca	Spain	180G	1 067	228 500	901 600	Limestone	1950
17A	Albina 11 - 30	Albina		Spain	100G		24 000		Limestone	1945
17B	Alborelo 9	Valsura	Trentino - Alto Adige	Italy	190G	390	110 000	2 670	Schist	1954
17C	Alcamines 11			Spain	184G	676	118 000	14 700		Proposed
18A	Aldeadavila 11	Duero		Spain	387A			86 800		Proposed
22	Alicante (Tibi) 11 - 34	Monegre	Alicante	Spain	134G	190	47 500	3 300		1584
23A	Alloz 11 - 34	Salado	Navarra	Spain	205A	241		68 100	Limestone	1929
25A	Almus 12	Yesilirmak	Tokat	Turkey	202RF	1 066	179 200	304 000	Andesite-Alluvial	Proposed
26	Alpe Cavalli 25 - 9	Loranco	Piemonte	Italy	121RF	548	175 000	7 000	Moraine Prasinite Limestone	1925
27A	Alta Merse 9	Merse	Toscana	Italy	184B	643	131 000	44 000	Quartz Sandstone Schist	1956
27B	Alto Mora 25	Mora (Brembo)	Bergamo	Italy	142G			700		Under Const.
27C	Alta Valle Mora 9	Mora	Lombardia	Italy	132G	648	44 700	682	Tuff Sandstone	1953
27D	Alvito 49	Ocreza		Portugal	410A	1 470	655 000	1 380 400	Quartzite	Proposed
29A	Amadorio 11 - 34	Relleu	Alicante	Spain	157G	968	390 000	13 000	Marl	Under Const.
32	Ampollino see Trepido 9									
33	Amsteg see Pfaffensprung 44									
34	Anchicaya 30	Anchicaya	Valle	Colombia	180G	625	134 000	4 100	Diorite	1954
36	Ancipa 25 - 9	Troina	Sicily	Italy	305B	830	392 000	24 600	Sandstone	1952
41A	Antonio Luchetti (Yauco) 31A	Yauco		Puerto Rico	178G	591	102 000	15 800	Andesite	1952
44A	Arancio see Carboi 25									
45	Arapuni 45	Waikato	Auckland	New Zealand	210G	307	100 000	27 000	Ignimbrite	1928
45A	Arborelo 25	Valsura (Adige)	Bolzano	Italy	197G			2 700		In Const.
48A	Arlanzon 11 - 34	Arlanzon	Burgos	Spain	141G	606	196 000	16 200	Quartzite	1933
55	Asahi 29	Masuda	Tokai	Japan	240A	700	120 000	10 000	Quartz Porphyry	Proposed
62A	Asse Dasse 49	Mondego		Portugal	230A			40 600	Granite	Proposed
64	Aussois 7 - 5	Torrent d'Avrieux	Savoie	France	165A 180B	340 852	97 000	3 240	Schist	1950
64A	Aussois (upstream) 5	Torrent d'Avrieux	Savoie	France	140B	1 150	156 000	6 500	Schist	Proposed
67	Avino 9 - 39 Delete									
73	Badana 9	Gorzente	Liguria	Italy	182G	722	130 000	3 800	Serpentine	1914
75	Baitone 9	Lake Baitone	Lombardia	Italy	125G	745	65 000	15 200	Gneiss Granite	1931

77	Bakhadda	13	Mina		Algeria	148RF	722	418 000	30 000	Marly Sandstone	1936
78A	Balcon de Pilatos	11 - 34	Tajo		Spain	184G	952	247 000	172 700		Proposed
81	Balze di S.Lucia (Salto)	9	Salto	Lazio	Italy	341G	605	470 000	225 000	Limestone	1939
82	Ban (Rive sur le Ban)	7	Ban	Loire	France	154G	540	72 000	1 500	Micaschist	1870
82A	Ban de Champagney	33	Sernillots		France	131G	2 575	260 700	10 500	Marly Sandstone	1930
82B	Bao	11	Bibey		Spain	331A	830	398 000	204 500	Gneiss	Proposed
82C	Barasona	11 - 34	Esera	Huesea	Spain	181G	230	28 000	57 600	Limestone	1932
83	Barbellino (Pian del Barbellino)	9 - 25	Serio	Lombardia	Italy	206G	840	168 000	15 300	Slatey Schist	1931
84	Barberine	44 - 19	Barberine	Valais	Switzerland	262G	950	270 000	31 000	Gneiss	1925
84A	Barcena	11 - 34	Sil	Leon	Spain	276G	507		159 700	Granite	1957
84B	Barcis	25 - 9	Cellina	Veneto	Italy	171A	240	7 300	16 200	Limestone	1953
89	Barrea	9 - 36 - 25	Sangro	Abruzzi	Italy	205A	112	5 050	19 700	Clay-Sandstone Schists	1952
91	Barrett Chute	15	Madawaska	Ontario	Canada	100G	1 170	61 300	25 900	Crystalline Limestone	1942
91A	Barrie de la Maza see Tambre 34										
95	Bathie see Roseland	5									
96	Bau Muggeris	9 - 25 - 36	Flumendosa	Sardegna	Italy	190B	765	172 000	49 800	Phyllitic Schist	1950
96A	Barrios de Luna	11 - 34	Luna	Leon	Spain	266G	926	370 000	249 700	Quarzite	1954
96B	Bayas	11	Bayas		Spain	118G		108 500	77 000		Under Const.
97	Bear Creek	2	E.F. Tuckasegee	N.Carolina	U.S.A.	215RF	740	1 000 000	34 700	Granite	1954
99A	Beauregard	9 - 25	Grisanche	Aosta	Italy	433AG	1 290	431 000	56 800	Mica Schist	1957
104	Bekhme		Greater Zah		Iraq	550G					1957
104A	Belezar	11	Mino		Spain	328G			194 600	Granite	Proposed
104B	Bellevaux	33 - 7	Brepon	Haute Savoie	France	105A	39	850	80	Limestone	1927
105A	Bellicai	9 - 25	Bellicai	Sardegna	Italy	110AG	524	22 500	780	Sandstone	1953
107A	Bembezar	11	Bembezar		Spain	290G	890		252 600		Under Const.
107B	Bemposta	49	Douro		Portugal	230G				Granite	Proposed
110	Sengal	1 Delete									
111	Benhopai	45	Waihopai		New Zealand	120A	184	6 600	Silted up	Sandstone	1927
111A	Benlarries	11 - 34	Serpis	Alicante	Spain	121G	755	88 500	22 600		Under Const.
112	Beni - Bahdel	13	Tafna		Algeria	180MA	1 148		51 000	Schist	1944
112A	Ben Metir	7 - 24	Oued Elhil		Tunisia	196B	1 480	460 000	65 000	Marly Sandstone	1954
112B	Bermejales	11 - 34	Bermejales	Granada	Spain	184G	1 338		83 300		1951
113A	Bhadra	1	Bhadra	Mysore	India	230G	1 320	848 000	1 609 000	Chlorite Schist	1956
115	Bhakra	1 - 8A	Sutlej	Punjab	India	680	1 700	5 120 000	7 400 000	Thick Bedded Sandstone	1960
116	Big Carson see Peters										
133	Bimont	5 - 7 - 33	Infernet	Bouches du Rhone	France	290A	850	120 000	32 400	Limestone	1952
134	Bin el Ouidane	3 - 7	Oued el Abid	Casablanca	Morocco	434A	950	340 000	1 060 000	Limestone	1953
137	Bionia (LeMesce)	9	Bionia		France	215G	474	153 000	1 200	Gneiss	1917
138	Bissorte	33 - 5	Bissorte	Savoir	France	207G	1 787	393 000	32 400	Sandstone	1936
149	Blue Ridge	8A	Toccoa	Georgia	U.S.A.	167E	1 000		197 500	Schist	1931
153A	Bois de Chaumecon	7 - 33	Chalaux	Nierre	France	141G	653	94 300	16 200	Granite	1933
153B	Bois d'etat	33	Echapre		France	164G	607		900	Gneiss	1898
160A	Borgiana	9 - 25 - 4	Chienti	Marche	Italy	103G	290	31 000	4 460	Marl	1956
160B	Bornos	11	Guadalete		Spain	131G	371		168 600		Under Const.
161	Bort	7 - 33	Dordogne	Correze	France	393A	1 279	872 500	324 400	Gneiss, Mica-Schist	1952
162	Boschi	9 - 25	Aveto	Emilia	Italy	118G	355	50 000	960	Sandstone-Schist	1930
162A	Bouca	49	Zezere		Portugal	213A	720	45 850	40 600	Granite Gneiss	1955
164	Bou-Hanifia	13	Oued el Hammam		Algeria	177RF	1 522	981 000	58 000	Marl	1948

TABLE I (CONT'D)

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

REF. NO.	NAME		RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
165A	Bou Vante	33 - 7	Lyonne	Drome	France	114G	148	10 500	3 400	Limestone	1926
171	Brasimone see Scalere	9									
173	Brembo see Lago Sardegnana	9									
174	Brena	11 - 34	Guadiato	Cordoba	Spain	197G	653	144 000	104 000		1935
177	Bridge R. (LaJoie) see LaJoie	31									
180	Bromme	33	Bromme	Aveyron	France	131A	239	16 900	250	Granite	1932
181A	Brugneto	9	Brugneto	Liguria	Italy	263C	926	220 000	20 200	Argillaceous Schist	1957
186A	Buendia	34	Guadiela	Guadalajara	Spain	256G	1 148	649 500	1 230 700	Limestone	1954
186B	Buford		Chattahoochie	Georgia	U.S.A.	200E	1 630	5 000 000	1 885 000		1958
194	Burdekin Falls	16	Burdekin	Queensland	Australia	178G	2 700		6 584 000	Granite	Proposed
194A	Burguillo	11 - 34	Alberche	Avila	Spain	269G	1 047	382 000	154 000	Granite	1929
200	Buseo	11 - 25 - 34	Chera	Valencia	Spain	169G	279	36 000	6 000		1914
203A	Cabeco Monteiro	49	Ponsul		Portugal	177G	490	86 460	63 300	Granite	1948
205	Cabril	47 - 49	Zezere		Portugal	443A	1 180	432 300	584 000	Granite	1954
208	Cairn Curran	14	Loddon	Victoria	Australia	130E	2 330	1 000 000	120 000		1957
210	Cala	11 - 34	Ribera de Huelva	Sevilla	Spain	174G	1 381	129 000	48 700		1927
218	Camarasa	11 - 34	Noguera Pallaresa	Lerida	Spain	338G	460	281 500	127 600	Limestone	1920
219	Camarillas	11 - 34	Mundo	Murcia	Spain	141G	92	19 000	32 400	Limestone	Under Const.
219A	Cammazes	7	Sor	Tarn	France	220A	980	131 000	16 000	Schist	1956
219B	Campilhas	49	Sado		Portugal	115E	2 300	851 500	16 200	Shale	1953
220	Campliccioli	9 - 25	Troncone	Piemonte	Italy	230G	910	315 000	7 200	Gneiss	1926
221	Campo see Colombera	25									
222A	Camporredende	11 - 34	Carrion	Valencia	Spain	217G	525	261 500	57 000	Quartzite	1930
223	Campotosto see Rio Fucino	9 - 25									
224	Cancano di Fraele	9 - 25	Adda	Lombardia	Italy	190G	955	200 000	18 700	Dolomite	1929
224A	Cancano di Fraele Nuova	9	Adda	Lombardia	Italy	265AG	1 575	641 000	19 350	Limestone	1957
225A	Canelles		N. Ribgorzana	Lerida	Spain	495A		400 000	570 000		Under Const.
225B	Canicada	49	Cavado		Portugal	249A	807	104 800	50 300	Granite	1954
231	Cap de Long (Pragneres)	7 - 33	Ise	Htes Pyrenees	France	295CA	1 863	334 000	54 300	Granite	1954
232B	Carboi (Arancio)	25	Carboi	Sicilia	Italy	154A	452	41 800	28 700	Limestone	1951
233	Cardenello (Spluga)	9 - 25	Liro	Lombardia	Italy	238G	800	160 900	26 300	Gneiss	1932
235	Careser	9 - 25	Careser	Trentino	Italy	203G	1 455	248 000	12 400	Quartz Gneiss	1935
240A	Carrapatelo	49	Douro		Portugal	131G				Granite	Proposed
242	Casere (Pian Casere)	9 - 25	Borleggia	Lombardia	Italy	142G	380				1947
243	Castello	9 - 25	Varaita	Piemonte	Italy	240G	778	264 000	10 100	Limestone, Schist	1922
244	Casteinau-Lassouts	5 - 7 - 33	Lot	Aveyron	France	187G	597	161 100	32 400	Gneiss, Mica - Schist	1946
245	Castelo do Bode	49	Zezere		Portugal	377A	1 150	563 300	893 200	Crys. Schist	1950
246	Castiletto	19 - 44	Julia	Graubunden	Switzerland	230E	1 230	3 530 000	48 600	Gneiss	1954
247	Castillon	5 - 7 - 33	Verdon	Basses Alpes	France	328A	656	163 700	121 600	Limestone	1949
247A	Castro	11 - 30	Duero		Spain	171G	459	170 000	30 800	Gneiss	1952
248	Castrola	9 - 25 Delete									
251	Catawba		Catawba	N.Carolina	U.S.A.	120E					1919
252A	Cavagnac (Laila Takerkoust)	3 - 16A	Oued N'Fis	Marrakech	Morocco	203G	1 170	68 000	41 000	Granite	1935

253	Cavite	31A Delete									
255	Cecita	9 - 25 - 36	Mucone	Calabria	Italy	181AG	546	79 000	87 800	Granite	1952
257	Cedar Cliff	2	E.F. Tuckasegee	N.Carolina	U.S.A.	165RF	600	420 000	6 300	Arkose Schist	1952
259	Ceira	49	Ceira		Portugal	123A	300	76 000	1 070	Schist	1949
259A	Cenajo	11 - 34	Segura	Albacete	Spain	276G	630	460 500	354 400	Limestone	Under Const.
261	Ceppo Morelli	9 - 25	Anza	Piemonte	Italy	147A	120	12 000	380	Gneiss	1930
262	Ceresole Reale	9 - 25	Orco	Piemonte	Italy	172G	985	194 000	28 200	Gneiss Granite	1931
262A	Cervera	11 - 34	Ribera	Valencia	Spain	100G	427	53 000	7 300	Limestone	1924
263	Chamarajasagar	1	Arlavathi	Mysore	India	152G	1 400	17 300	70 000	Grey Gneiss	1933
264	Chambal	1	Chambal	Madhya Bharat	India	222G	1 250	963 000	4 190 000	Sandstone	1958
265	Chambon	5 - 33	Romanche	Isere	France	367G	1 080	392 000	46 500	Gneiss, Limestone	1935
266A	Chanakpur	1 Delete									
266B	Chandreja	11 - 34	Navea	Orense	Spain	276B	774	188 000	49 200	Granite	1953
266C	Charco del Cura	11 - 34	Alberche	Avila	Spain	112G	474		3 200	Granite	1929
266D	Chankapur	1	Girna	Bombay	India	140G	1 506	81 000	34 000	Hard Rock	1911
268	Chartrain (Tache)	7 - 33	Tache	Loire	France	177G	738		3 400	Granite	1951
269	Chastang	5 - 7 - 33	Dordogne	Correze	France	288GA	984	340 600	145 900	Granite	1951
269A	Chatelot (Lac de Moron)	33 - 44	Doubs	Neuchatel/ Doubs	Switzerland/ France	243A	492	62 600	16 200	Limestone	1953
270	Chatra	47									
272	Chaudanne	5 - 7 - 33	Verdon	Basses Alpes	France	243A	312	32 750	12 900	Limestone	1953
273	Chavanon	7 Delete									
274	Cheat Haven (Lake Lynn)	8A	Cheat	W.Va./Pa.	U.S.A.	100G		180 000	87 000	Shale & Sandstone	1920
277	Cheoah	8A	Little Tennessee	N. C.	U.S.A.	230G	770	200 000	31 000	Arkose & Slate	1919
278	Cher see Rochebut	7									
286A	Chisaca	30	Chisaca		Colombia	111E	1 210	570 000	4 000	Shale	1951
287	Chiusella (Gurzia) see Gole di Gurzia	9									
288A	Chorro	11 - 34	Turon	Malaga	Spain	262G	525	170 000	69 800	Sandstone	1921
291A	Chute a la Savane	8	Peribonka	Quebec	Canada	166G	3 150	407 300	115 000	Anorthosite	1953
291B	Chute du Diable	8	Peribonka	Quebec	Canada	160G	1 920	339 900	321 000	Anorthosite	1952
291C	Cifuentes	34	Isuela		Spain	100G					1928
292	Cignana No.1	9 - 25	La Plana	Aosta	Italy	189G	1 320	200 000	13 100	Amphybolite Schist	1929
293A	Cijara	11 - 34	Guadiana	Badajos	Spain	231G	929	363 000	871 400	Quartzite	1954
294A	Cingino	9 - 25	Sangoria	Piemonte	Italy	154G	486	66 000	4 200	Gneiss	1931
295	Cismon see Ponte della Serra	9									
297	Clark	32 - 47	Derwent	Tasmania	Australia	200A	1 110	200 000	249 600	Dolerite	1950
304	Cleuson	19	Printse	Valais	Switzerland	285B	1 375	524 000	16 000	Gneiss	1950
304A	Cleveland		Capilano	B.C.	Canada	325G	640	150 000			1954
305A	Cobb	45	Cobb		New Zealand	110E	670	480 000	23 000	Magnesite	1955
308	Codelago	9 - 25	Arbola	Novara	Italy	100RF	380	69 700	13 000	Dolomite	1912(1921)
309	Coghinas see Oschiri	9 - 25									
310	Cohilla	11 - 34	Nansa	Santander	Spain	381A	680		9 000	Conglomerate	1950
312	Colombera (Campo)	9	Tartano	Lombardia	Italy	197G	203	51 000	1 450	Gneiss	1929
313	Colombo	9 - 25	Borleggia	Lombardia	Italy	102G	426	38 000	2 350	Slate	1929
314	Combamala	9 - 25	Combamala	Piemonte	Italy	128B	308	13 100	300	Dolomite	1916
315	Comelico	9 - 25	Piave	Veneto	Italy	218A	361	40 000	1 700	Dolomite	1931
315A	Comerford see Fifteen Mile Falls	8A									
316	Comerio	31A	La Plata		Puerto Rico	128B	480	40 000	4 900	Andesite tuff & Agglom	1913
316A	Compuerto	11	Carrion		Spain	253G	886		77 000	Sandstone	Under Const.
320A	Confolent	7 - 33	Creuse	Creuse	France	111G	456	43 200	4 800	Gneiss	1928

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
321	Conklingville (Sacandaga) 8A	Sacandaga	N.Y.	U.S.A.	100E	1 000	790 000	690 000	Earth & Granite Gneiss	1930
324A	Contreras 11	Cabriel		Spain	325G			713 500	Limestone	Proposed
325	Cooby Creek 16	Cooby Creek	Queensland	Australia	103RF	678	127 000	18 700	Basalt	1941
330	Corangin Delete									
330A	Corcovado 11 - 34	Mula	Murcia	Spain	194G	295		5 000		1920
332	Corfino 9 - 19 - 25	Corfino	Toscana	Italy	131A	220	2 620	700	Diabase	1914
332A	Corlo 9 - 25	Cismon	Veneto	Italy	233A	293	32 000	390	Limestone	1953
332B	Corongiu No. 3 9 - 25	Bauvilixi	Sardegna	Italy	147G	589	92 000	3 500	Biotite Granite	1937
334	Cotatay 7 - 33	Cotatay	Loire	France	121G	508		650	Gneiss	1892
336	Couesque 7 - 33	Truyere	Aveyron	France	216A	892	99 500	45 400	Granite	1950
337	Cougar Creek	S.F. McKenzie	Washington	U.S.A.	335RF					Proposed
337A	Couzon 7 - 33	Couzon	Loire	France	111E	669		1 150	Sandstone	1811
337B	Covalo do Meio 49	Loriga		Portugal	102A	430	13 100	2 400	Granite	1953
340A	Crescent 7 - 33	Cure	Yonne	France	128G	1 082	47 100	11 500	Granite	1632
340B	Crespia 11 - 34	Fluvia		Spain	120G	504	99 000	52 700		Proposed
341A	Creva 25	Tresa	Varese	Italy	100G	197	138 000	800	Crys. Schist	1929
343	Crosis see DiCrosis 25									
346	Cruz del Eje 10	Cruz del Eje	Cordoba	Argentina	128BE	10 105		101 300		1944
347	Cruz de Piedra 10 Delete									
349A	Cubillas 11 - 34	Cubillas	Granada	Spain	125E	646		19 500		1950
351A	Cuerda del Pozo 11 - 34	Duero	Soria	Spain	132G	1 460	170 000	142 700	Sandstone	1941
351B	Cueva Foradada 11	Martin	Teruel	Spain	148G	369	74 500	21 300	Limestone	1920
357	Cushman No. 2 (Potlatch) 8A	N.F. Skokomish	Washington	U.S.A.	240A	500	38 000		Basalt	1930
363	Dardennes 7 - 33	Dardennes	Var	France	115G	508	53 800	1 000	Limestone	1912
363A	Daourat 3 - 16A	Oum er R'bia	Casablanca	Morocco	131B	410	31 400	18 900	Quartzite	1950
369A	Deer Creek Diversion 8A	Deer Creek	California	U.S.A.	112A		9 000			1930
370A	Della Stua 25	Caorame	Belluno	Italy	197G			3 300		1953
371A	Demirkopru 12	Gediz	Manisa	Turkey	253E	1 657	4 591 000	1 297 000	Basalt Gneiss	1957
	Derbendi Khan	Ciala		Iraq	400G					Proposed
374	Des Joachims - Main Dam 15	Ottawa	Ontario	Canada	180G	2 370	398 300	186 000	Gneiss	1950
	- McConnell Dam 15	Ottawa	Ontario	Canada	130G	1 620	270 900	186 000	Gneiss	1950
378	Di Crosis (Torre) 9	Torre	Veneto	Italy	131A	210		100	Dolomite	1901
381	Dihue Delete									
381A	Dihua 6	Longavi	Linares	Chile	264E	990	3 250 000	163 000		Proposed
383	Dissueri (Gela) 9 - 25	Gela	Sicilia	Italy	135RF	990	493 000	11 300	Clay, Limestone	1950
385	Dixence 44	Dixence	Valais	Switzerland	285B	1 500	552 000	40 500	Gneiss	1935
387A	Dobra 4	Kamp	Lower Austria	Austria	170A	722	116 000	15 000	Gneiss	1953
390	Doiras 11 - 34	Navia	Oviedo	Spain	290G			75 400	Slate	1935
391	Donets Delete									
397	Dos Bocas 31A	Rio Grande de Arecibo		Puerto Rico	188G	1 317	301 400	32 000	Andesite	1942
400	Doustre see Marcillac 7									
404A	Drossen see Mooserboden 4									
414A	Ebro 11	Ebro		Spain	115G	705		437 800	Sandstone	1949

419A	Eggschi (Rabiusa)	44	Rabiusa	Graubunden	Switzerland	128G	262	40 500	450	Gneiss	1949
420	Eguzon	5 - 7 - 33	Creuse	Indre	France	203G	836	288 200	46 500	Gneiss	1912
421	Eildon	14 - 38	Goulburn/Delatite	Victoria	Australia	259E	3 000	13 300 000	2 750 000	Sandstone & Shale	1936(1955)
427A	El Kansera see Kansera	3 - 16A									
431	Enchanet	5 - 7 - 33	Maronne	Cantal	France	246A	755	85 100	73 000	Schist, Basalt	1926
437A	Enobieta	11			Spain	131G	755		4 000		1950
437B	Entrepanas	11 - 34	Tajo	Guadalajara	Spain	262G	919	550 500	612 000	Limestone	1954
437C	Erlaufklause	4	Erlauf	Lower Austria	Austria	115G	282	29 000	1 200	Limestone	1910
438	Ermal see Guilhofrei	49									
440	Escaba	10	Marapa	Tucuman	Argentina	272B	764		113 500		1949
440A	Escales	11 - 30 - 34	Noguera Ribagorzana	Lerida	Spain	394G	575	500 000	128 100	Limestone	Under Constr.
441A	Esla see Ricobayo	34									
441B	Esmeralda	30	Esmeralda	Caldas	Colombia	131E	1 200	730 000	3 000	Conglomerate	Proposed
442A	Estrecho de Pennaroya	11	Guadiana		Spain	107G	790		36 400		Under Constr.
443	Etzel	19 - 44	Sihl	Schwyz	Switzerland	108G	411	28 800	74 200	Gneiss	1937
447	Fabreges	5 - 7 - 8A - 33	Bousset	Basses Pyrenees	France	174A	541	47 100	5 600	Schist, Limestone	1947
447A	Fades	7 - 33 - 38	Sioule	Puy de Dome	France	111G	394	57 600	4 800	Granite	1917
452A	Fanaco see Platani	25									
453A	Fedaia	9 - 25	Avisio	Trentino Alto Adige	Italy	212B	2 040	226 000	13 500	Dolomite	1954
453B	Fergoug	13	Oued el Hammam		Algeria	115G					1871*
455	Fiastrone	9 - 25	Fiastrone R.	Marche	Italy	286AG	870	200 000	16 500	Limestone	1953
456	Fifteen Mile Falls (Comerford)	8A	Connecticut R.	N.H. - Vt.	U.S.A.	170GE	2 250			Glacial Drift, Schist, Diabase	1930
457	Fisch (Lago del Toggia)(Valtoggia)	9-25	Toce	Piemonte	Italy	154G	660	120 000	12 700	Quartz Gneiss	1932
458	Fish's Eddy	Delete									
460	Flatbrook	Delete									
462A	Foix	11 - 34	Foix R.	Barcelona	Spain	105G	568	43 000	30 600		1926
463A	Fonni	9	Govossai	Sardegna	Italy	128G	426	35 400	3 100	Granite	1953
464A	Fontanaluccia see Musehidsa	25									
464B	Forata	11 - 34	Magro	Valencia	Spain	187G	902	131 500	2 700		in Constr.
464C	Fora dei Camini	9	Avisio	Trentino Alto Adige	Italy	205A	329	30 000			1957
466	Forte Buso	9 - 25	Travignola	Trento	Italy	361AG	1 053	340 000	26 000	Gneiss, Schist	1951
467	Fortezza	9 - 25 - 36	Isarco	Trento	Italy	196A	188	19 600	1 620	Granite	1940
472A	Foum el Gherza	7 - 13	Oued el Aboid		Algeria	213A	610	52 000	35 000	Limestone	1951
472B	Foum el Gueiss	7	Oued Gueiss		Algeria	118E	840	157 000	2 000		1948
472C	Fragas da Torre	49	Paiva		Portugal	295A			209 500	Quartzite	Proposed
474A	Fraser	45	Fraser		New Zealand	107A	450	9 000	4 100	Schist	1937
474B	Fregabolgia	9	Bremio	Lombardia	Italy	180G	633	117 000	3 780	Quartz - Schist	1952
479	Fuensanta	11 - 34	Segura	Albacete	Spain	272G	722	353 000	192 100		1935
484	Furens see Gouffre d'Enfer	7 - 33									
485	Furio	9 - 25	Candigliano	Marche	Italy	204GA	164	20 000	2 500	Limestone	1921
488	Fusino	9 - 25	Roasco	Lombardia	Italy	192GA	236	35 000	1 700	Gneiss, Schist	1924
	Futseling		Huai		China	243MA	1 700				1954
490	Gabiet	9	Lago Gabiet	Valle d'Aosta	Italy	141G	695	102 000	3 570	Serpentine	1922
490A	Gabriel y Galan	11 - 34	Alagon	Caceres	Spain	239G	3 343	743 000	749 200	Granite	1958
490B	Gage	7 - 33	Gage	Ardeche	France	131A	469	12 400	2 670	Granite	1954
490C	Gallipuen	11 - 34	Guadalopillo	Teruel	Spain	108G	591	54 000	3 500		1927

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REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
491	Gal Oya 1 - 47	Gal Oya		Ceylon	105E	4 650	6 267 000	770 000	Biotite, Gneiss	1952
491A	Gammauta 25	Sosio	Sicilia	Italy	108G	328	40 600	1 600	Limestone	1938
491B	Gangapur 1		Bombay	India	140E	12 500	5 185 000	165 000		1953
492	Gangheri (Turrite) 9	Turrite di Gallicano	Toscana	Italy	138A	192	12 000	755	Dolomite, Limestone	1922
493A	Garichte 44	Niedererenbach	Glarus	Switzerland	138G	752	73 200	2 430	Gneiss	1931
496	Garzas 31A	Vaca		Puerto Rico	202E	910	1 031 000	4 700	Andesite, Agglomorate Tuff	1943
501	Gedre (Gloriettes) 5 - 7	Estaube	Pyrenees	France	131A	505	26 000	2 200	Gneiss, Mica, Biste	1949
503	Gela see Dissueri 9 - 25 - 36									
504	Gelmer 19 - 44	Aare	Berne	Switzerland	114G	1 210	106 000	1 050	Granite	1931
506	Gemelli (Laghi) 9	Borleggia	Lombardia	Italy	121G	650	64 000	5 670	Staty, Quartz, Schist	1932
507A	Generalisimo 11 - 34	Turia	Valencia	Spain	340G	672	504 500	206 700	Limestone	1949
509	Genissiat 7 - 19 - 33	Rhone	Ain	France	341G	656	576 400	42 910	Limestone	1948
510A	George W. Rayner (Mississagi) 15	Mississagi	Ontario	Canada	239G	826	170 400	69 000	Diorite	1950
511	Gerlos 4	Ziller	Tyrol	Austria	128A	230	13 000	700	Quartzite Slate	1944
514	Ghrib 13	Cheliff		Algeria	213RF	685	915 000	227 000	Sandstone Marl	1939
515	Giacopiane 9 - 25	Calandrino	Liguria	Italy	146G	670	45 000	3 900	Diabase Serpentine	1925
521A	Gioveretto 9	Plima	Trentino Alto Adige.	Italy	266B	1 240	366 000	16 200	Orthogneiss	1957
522	Girotte 5 - 7 - 19 - 33	Dorinet	Savoie	France	131MA	1 640	157 200	16 200	Lias, Crystalline	1949
525A	Glendevon	Devon	Fife	Scotland	160G	1 300	160 000			1955
525B	Glendo	N. Platte	Wyoming	U.S.A.	203E	3 407		1 088 000		1959
526	Glenmaggie 14	MacAlister	Victoria	Australia	100G		80 000	106 000		1929
529	Glenville see Thorpe 2									
534	Gnioure 5 - 33	Gnioure	Ariege	France	236G	918	262 000	22 700	Granite Gneiss	1949
537	Gole di Gurzia (Chiusella) 9	Chiusella	Piemonte	Italy	154A	259	14 000	1 000	Lherzolite	1926
538A	Gonzales Lacasa 11 - 34	Iregna	Logrono	Spain	197G	961	405 000	24 300		1950
541A	Gorge	Skagit	Washington	U.S.A.	200AG	650				Proposed
543	Gorzente see Lago Lungo 9 - 36									
543A	Goscheneralp 44	Goschener-Reuss	Uri	Switzerland	393RF	1 830	8 500 000	60 800		Proposed
543B	Gouffre d'Enfer (Furens) 7 - 33	Furan	Loire	France	197G	344	52 400	1 300	Granite	1866
544	Gour Noir 5 - 7 - 33	Maronne	Correze	France	131A	328	19 100	3 400	Granite	1946
499A	Gavossai 25	Gavossai	Sardegna	Italy	111G			2 400		In Constr.
544B	Gramolazzo 25	Serchio di Gramolazzo	Lucca	Italy	123G			3 000		1952
545B	Grandas de Salime 11	Navia		Spain	441G	826	850 000	227 000	Slate	1953
546	Gran Cheurfas 7 Delete									
548	Grande Dixence 19 - 44	Dixence	Valais	Switzerland	580G	1 475	2 260 000		Granite	1956
	Grande Dixence (Second Stage)				921G	2 480	7 850 000	32 400		Proposed
549	Grande Rhue 5 - 7 - 33 - 35	Grande Rhue	Cantal	France	164G	295	29 600	2 300	Granite Gneiss	1926
549A	Grands Cheurfas 7	Oued McKerra		Algeria	131G	490	92 000	5 200	Limestone	1882(1936)
549B	Grangent 33	Loire		France	187A	656	86 400	46 200	Granite	Proposed
553A	Green Peter	Santiam	Oregon	U.S.A.	370RF	1 180		322 000		Proposed
557	Grimsel Spitallamm 19 - 44	Aare	Berne	Switzerland	374AG	848	445 000	81 000	Granite	1932
	Seuferegg	Aare	Berne	Switzerland	138G	1 150	91 800	81 000		1932
557A	Grotta Campanaro 9 - 25	Melfa	Lazio	Italy	161A	214	5 100	300	Dolomite	1954
558A	Guadalcacin 11 - 34	Majaceite	Cadiz	Spain	100G	264		56 800		1932
558B	Guadalen 11 - 34	Guadalen	Jaen	Spain	187G	1 023	146 500	140 300		1954

558C	Guadalest	11	Callosa		Spain	223G	740	294 000	12 600		Proposed
558D	Guadalmellato	11 - 34	Guadalmellato	Cordoba	Spain	184G	1 607		131 400		1950
560	Guayabal	31A	Jacagnas		Puerto Rico	120B	920	44 000	10 000	Diorite	1913
562	Guayataca	31A	Guayataca		Puerto Rico	110E	900	520 000	28 000	Limestone	1924
562A	Guayo	31A	Guayo		Puerto Rico	220G	556	114 000	17 400	Andesite, Tuff & Agglom.	1955
564	Guerde del Pozo	Delete									
564A	Guerledan	5 - 7 - 33	Blavet	Morbihan	France	148G	659	137 500	40 400	Sandstone	1929
565A	Guido Donegani	25	Mannu	Sardegna	Italy	106G	394	22 800	250	Schist	1950
565B	Guilhofrei (Ermal)	49	Ave		Portugal	161G	620	72 000	17 900	Granite	1938
566	Guineo	31A	Toro Negro		Puerto Rico	125RF	565	319 300	2 180	Volcanic Breccia	1931
566A	Guistolas	11 - 30 - 34	Navea	Orense	Spain	105G	407	31 500	3 800	Gneiss	1951
567	Gurzia see Chiusella	25									
569	Habra	13 Delete									
570	Habu	29	Yahagi	Tokai	Japan	210G	1 000	353 000	13 100	Granite & Schist	1957
572	Hamiz	13	Hamiz		Algeria	14PG	728	157 000	18 600	Schist	1879(1953)
575A	Harriman see Davis Bridge	8A									
578	Harsi	1	Parvati	Madhya Bharat	India	104E	7 000	2 580 000	155 000	Igneous Rock	1937
592A	Hierzmann	4	Teigitsch	Styria	Austria	190A	590	56 000	5 500	Gneiss	1944
594	Hijar No. 1	11 - 34	Martin	Ternel	Spain	142G	236		4 900		1880
595	Hijar No. 2	34	Martin	Ternel	Spain	141G					1880
597	Hirakud	1	Mahanadi	Orissa	India	200EG	16 000	27 000 000	6 750 000	Granite Gneiss	1956
598A	Hirebhasgar	1	Sharavati	Mysore	India	116G	3 870	748 900	578 000	Rock	1947
598B	Hirfanli	12	Kizilirmak	Kirsehir	Turkey	282RF	1 444	2 812 100	5 107 400	Granite	1958
601	Hiwassee	8A	Hiwassee	N.C.	U.S.A.	307G	1 287	807 200	438 000	Greywacke	1940
602	Hobart	32	Ridgeway	Tasmania	Australia	100G	604	106 000	200	Dolerite	1892
605	Hogback	Delete									
609	Hone see Piana dei Greci	9									
611	Hong Kong	28 Delete									
	Hoover		Big Walnut Creek	Ohio	U.S.A.	115EG	2 525	830 000	60 000		1955
627	Hume	14	Murray	Victoria	Australia	142EG	5 300	4 774 000	2 000 000		1933(1956)
633	I'am Fout	7 Delete									
638	Idaho Irrigation Co.	Delete									
639	Idanha see Cabeco Monteiro										
641	Ikari	29	Ozika	Kanto	Japan	354G	1 050	655 000	40 000	Granite	1956
643	Ikushunbetsu	29	Ishikari	Hokkaido	Japan	210G	1 250	355 000	73 000	Sandstone	1956
643A	I'am Fout	3 - 7	Oum er R'bia	Casablanca	Morocco	164G	655	108 600	67 500	Quartzite and Schist	1944
645	Inferno	9	Lago Inferno	Lombardia	Italy	126B	500	51 000	3 300	Sandstone	1945
649	Iril Emda	7 - 13	Oued Agrioun		Algeria	246E	1 880	4 086 000	130 000	Schist	1954
650	Irrigation Dam see Rio Tercero	10									
651A	Isbert	34	Girona	Alicante	Spain	203A	51	3 000	6 000		In Constr.
652	Ishibuchi	29	Kitakami	Tohoko	Japan	174RF	1 120	570 000	13 000	Liparite	1952
654A	Isola Santa	9 - 25	Turrite Secca	Toscana	Italy	125G	414	40 000	630	Schist	1950
654B	Isolato	9 - 25	Liro	Lombardia	Italy	121A	260	8 500	1 430	Gneiss Schist	1951
656A	Iznajar	11	Genil		Spain	410G		1 570 000	1 216 000	Limestone	Proposed
657A	Jalaput	1		Madras/Orissa	India	158G	1 825	298 500	58 200	Charnockite & Laterite	1955

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TABLE I (CONT'D)

REF. NO.	NAME		RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
658	Jandula	11 - 34	Jandula	Jaen	Spain	295G	830	412 500	283 800	Granite	1930
659	Jawai	47	Jawai	Jodhpur	India	12RG	2 800				Proposed
659A	Jauja	11	Genil		Spain	115B	722		23 500		1950
665	Jogne, La see Monsalvens	44 - 19									
668A	Jorba	11	Noya		Spain	147RF	1 155	515 000	7 600	Shale	Proposed
669	Jordan	8A	Coosa	Ala	U.S.A.	125G	2 066		40 000	Schist	1929
670	Jordan	Delete									
672A	Jotty	33	Morzine		France	184A	453	15 800	900	Limestone	1949
672B	Jubilee (Shing Mun)	28	Shing Mun		Hong Kong	285RF	700	180 000G 480 000RF	10 790	Granite & Boulders	1936
679	Kaketo	1	Parvati	Madhya Bharat	India	107G	3 435	222 000	57 000	Fissued Rock	1933
685	Kamikotori	29	Kotori	Tokai	Japan	344G	1 070	870 000	72 000	Gneissase Granite	1958
696	Kansera, El	3	Oued Beth	Rabat	Morocco	206GB	600		184 000	Limestone	1935
697	Kaprun see Limberg	19									
699	Karapiro	45 - 47	Waikato	Auckland	New Zealand	172A	1 120	220 000	62 000	Sandstone	1947
700	Karnafulli		Karnafulli		Pakistan	120E	1 700				1958
707A	Kazaya	29	Totsu	Kinki	Japan	292G	950	680 000	57 000	Shale & Sandstone	Proposed
709A	Kemer	12	Akcay	Aydin	Turkey	358G	328	732 400	437 800	Limestone - Schist	Proposed
716	Kerrata	13	Oued Agrioun		Algeria	125A	361	11 800	770	Limestone	1944
729	Kodayar	1	Kodayar	Travancore	India	152G	1 396	161 000	81 000	Very Hard Rock	[illegible]
733	Komaki	29	Sho	Hokuriku	Japan	248G	1 000	390 000	14 700	Tuff Breccia Sandstone	1930
736	Konar	1 - 8A	Damodar	Bihar	India	160EG	12 600	6 220 000	260 000	Granitic & Micaceous Gneisses	1958
737	Koombooloomba	16	Tully	Queensland	Australia	160GE	1 160	250 000	152 000	Granite	Proposed
741A	Kowloon	28			Hong Kong	112G	600	36 300	1 300		1910
741B	Kowloon Bye Wosh	28			Hong Kong	144G	347	32 000	682		1931
744	Koyna	1	Koyna	Bombay	India	300G	3 400	2 000 000	156 000	Rock	Proposed
746	Krishnarajasagar	1	Cauvery	Mysore	India	146G	8 600	1 110 000	1 010 000	Gneiss, Granite, Schist	1932
750	Kurobe No. 4	29	Kurobe	Hokuriku	Japan	590G	1 065	2 800 000	118 000	Granite	1956
752	Kuromata No. 1	29	Shinano	Tohoku	Japan	299G	828	418 000	32 000	Ghert	1956
753	Kuromata No. 2	29	Shinano	Tohoku	Japan	263G	690	353 000	23 400	Granite	Proposed
757											
757	LaCave see Otto Holden	15									
757A	Lac Casse	31 - 42	Bersimis	Quebec	Canada	200RF	3 200	5 000 000	8 800 000	Gneiss	1955
757B	Lac de Moiry	44	Gougra	Valais	Switzerland	475AG	2 000	1 060 000	58 000		1959
757C	Lac de Moron see Chatelot	44									
761A	La Florida	10	Quinto	San Luis	Argentina	207B	978	167 700	85 100		1953
762	Lages	19	Lages	Miolesanura	Brazil	105G	800	89 000	147 000		1956
763A	Laghi Gemelli see Gemelli	25									
763B	Lago Badana see Badana	25									
763C	Lago Baitone see Baitone	25									
763D	Lago Benedetto	25	Avio	Brescia	Italy	120G	1 052	51 700	6 200	Tonalite	1940
763E	Lago Colombo see Colombo	25									
764	Lago d'Arno	9 - 25	Lago d'Arno	Lombardia	Italy	118G	520	29 000	30 800	Tonalite	1927
765	Lago d'Avio	9 - 25	Lago d'Avio	Lombardia	Italy	130G	1 004	92 000	14 000	Tonalite	1930
765A	Lago dell'Inferno see Inferno	25									

768	Lago del Toggia see Fisch	9									
767	Lago di Cignana see Cignana No. 1	9									
768	Lago di Mezzo	9 - 25	Lago di Mezzo	Lombardia	Italy	102G	607	20 400	400	Quartz Gneiss	1931
768A	Lago di Trona see Trona	25									
768B	Lago Fregabolgia see Fregabolgia	25									
768C	Lago Gabiet see Gabiet	25									
769	Lago Goillet (Marmore)	9 - 25	Lago Goillet	Aosta	Italy	151G	1 200	193 000	9 600	Amphibolite Moraine	1948
769A	Lago Lavezze see Lavezze	25									
770	Lago Lungo (Gorzente)	9 - 25	Gorzente	Liguria	Italy	160G	825	150 000	3 800	Serpentine	1904
771	Lago Nero	9 - 25	Goglio	Lombardia	Italy	118G	480	28 000	2 680	Guartziferous Porphyry	1928
771A	Lago Salarno see Salarno	25									
772	Lago Sardegnana (Brembo)	9 - 25	Brembo	Lombardia	Italy	125G	735	65 000	1 900	Siliceous Schist	1930
773	Lago Scuro (Spigno Monferrato)(Valla)	9	Valla	Piemonte	Italy	141A	360	31 000	2 340	Amphibolite	1925
773A	Lago Serru see Serru	9									
773B	Lago Truzzo	25	Truzzo	Sondrio	Italy	100G	749	81 400	15 400	Gneiss	1927
773C	Lago Vannino see Vannino	9 - 25									
773D	Lago Venina see Venina	9 - 25									
773E	Lago Verde (Cedra)	25	Cedra di Val di Tacca	Parma	Italy	100G	325	3 900	1 500	Moraine & Sandstone	1909
778	L'Aigle	3 - 7	Dordogne	Cantal Correze	France	312AG	951	320 000	160 000	Gneiss	1948
790	La Joie (Bridge R)	21 - 31	Bridge	B.C.	Canada	285RF	3 390	3 620 000	372 000		1950(1955)
793	Lake Manchester	16	Cabbage Tree Ck	Queensland	Australia	112G	640	58 000	26 000		1916
802	La Laguna	6	La Laguna	Coquimbo	Chile	135E	760	612 000	32 700		1937
803	Lalla Takerkoust see Cavagnac	7									
803A	La Maina di Sauris see Lumiei	25									
803B	Langli				Norway	125A					1940
803C	Laranjeiras	49	Sabor		Portugal	361A			430 400	Granite	Proposed
804	Lardit (Maury)	7 - 33	Selves	Aveyron	France	213A	610	94 000	27 000	Granite	1949
804A	Larecchio	9 - 25	Tomello	Piemonte	Italy	108G	538	50 000	2 160	Gneiss	1938
805	La Rioja	10	La Rioja	La Rioja	Argentina	141RF	469	355 800	17 000		1930
805A	La Rochetta see Rochetta	25									
805B	Las Conchas	11 - 34	Limia	Orense	Spain	151G	1 040	91 500	64 900	Granite	1948
805C	Las Torcas	11	Huerva		Spain	100G	328		7 300		1948
807	La Tuque	8A	St Maurice	Quebec	Canada	103G	1 337	270 000	257 000	Granite Gneiss	1940
807A	Lauchen	7	Lauch	Haut Rhin	France	108G	820	36 000	600		1894
809	Lavagnina Inferiore	9 - 25 - 36	Gorzente	Piemonte	Italy	131G	410	60 000	2 200	Serpentine	1917
810	Lavezze (Bruno)	9	Gorzente	Liguria	Italy	131G	476	42 000	2 900	Serpentine	1883
810A	La Vinia	10	Los Sauces	Cordoba	Argentina	331A	1 040	240 700	186 500		1943
816	Libby		Kootenai	Montana	U.S.A.	410G	2 700		5 985 000		Proposed
816A	Licq Atherey	7 - 33	St. Engrace	Basses Pyrenees	France	141G&A	180		300		1917(1952)
817	Limberg (Kaprun)	4 - 19	Kaprun	Salzburg	Austria	393A	1 150	585 000	66 500	Mica Schist	1951
817A	Linares del Arroyo	11 - 34	Riaza	Segovia	Spain	116G	322	57 500	48 700	Limestone	1950
820	Liro see Cardenello	9 - 19									
823A	Little Nerang	16	Little Nerang Ck	Queensland	Australia	142G	660	89 500	5 600	Greywacke	Proposed
825A	Littleton	8A	Connecticut	N.H./Vt.	U.S.A.	220EG	3 150	3 000 000		Glacia Drift & Schist	1956
827	Lloyd (Bhatgar or Lake Whiting)	1	Yelwandi	Bombay	India	194G	5 333	795 000	556 000	Deccon Trap	1928
838A	Loriguilla	11 - 34			Spain	179G	456	84 000	13 800		Proposed
839A	Los Molinos	10	Los Molinos	Cordoba	Argentina	184A	787	126 100	243 200		1953
842A	Lower Bhavani	1	Bhavani	Mysore	India	204EG	29 238	[illegible]	644 000		1952

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847	Lozoya 11 - 34	Lozoya	Madrid	Spain	105G	256				1852
848	Lucendro 19 - 44	Reuss	Ticino	Switzerland	236B	885	205 000	20 000	Granite	1947
850	Lumiei (LaMaina di Sauris) 9 - 25	Lumiei	Veneto	Italy	441A	454	131 000	58 000	Dolomite	1947
851	Lungo Delete									
851A	Luzege 5 - 7 - 33	Luzege	Correze	France	131A	328	11 800	2 400	Gneiss, Mica-Schist	1936
853	Madag (Madduk) 1		Bombay	India	144E	1 850	4 730 000	1 200	Slaty Clay	1858
861	Mahatma Gandhi 1	Sharavathi	Mysore	India	104 GE	3 870	900 000	580 000		19[illegible]4
864	Maithon 1 - 8A - 47	Barakar	Bihar	India	160G	10 000		1 000 000	Granite Gneiss	1956
866A	Malampuzha 1 - 47	Malampuzha	Madras	India	135G	5 866	259 800	179 000		1953
866B	Malan 1 - 33	Malan	Saurashtra	India	100E	6 345	504 000	13 000	Rock & Murrumish	1954
866C	Malciaussia 25	Sola	Torino	Italy	100A	358	9 600	930	Limestone Schist	1933
868A	Malpasset 7	Reyran	Var	France	230A	740	52 000	42 000	Gneiss	1954
869	Mangahao No. 1 45	Mangahao	Wellington	New Zealand	116G	791	37 500	4 000	Sandstone	1928
870	Mangahao No. 2 45	Mangahao	Wellington	New Zealand	104G	185	21 800	1 300	Sandstone	1925
871	Maniari 1	Maniari	Madhya Pradesh	India	113E	6 874	1 424 400	120 000	Metamorphic Rock	1933
871A	Manimuthar 1	Manimuthar	Madras	India	143EG	1 380	E 2 900 000 G 400 000	126 600	Gneiss	1956
872	Mannami 29	Mannami	Tokai	Japan	280G	920	450 000	35 000	Granite	19[illegible]8
874	Manogatani 29 Delete									
875	Manora 1	Mayar	Uttar Pradesh	India	655G	1 500	4 000 000	1 060 000	Quartzitic Slate	Proposed
877A	Mansilla 11 - 34	Najera	Najerilla	Spain	236G	682	288 000	59 200		Under Constr.
878	Manuherikia 45	Manuherikia	Otago	New Zealand	110RF	509	175 000	8 000	Sandstone	1935
879	Maraetai 45	Waikato	Auckland	New Zealand	284A	630	140 000	70 000	Ignimbrite	1951
880	Marakanawe Delete									
881	Maramsilli 1	Silauria	Madhya Pradesh	India	106E	8 500	1 650 000	131 000	Gneissose Granite	1923
881A	Maranhao 49	Seda		Portugal	164E	620	786 000	166 500	Shale	1936
884	Marcillac 7	Doustre	Correze	France	164A	600	35 000	26 000	Granulite	1949
885	Mareges 5 - 7 - 33 - 35	Dordogne	Correze	France	295A	649	242 300	38 000	Granite	1935
885A	Margaritzen Moell (N) 4	Moell	Carinthia	Austria	302A	557	46 000	3 200	Mica Schist	1953
	Margaritzen (S)	Moell	Carinthia	Austria	131G	564	43 000	3 200	Mica Schist	1953
886A	Maria Christina 11	Rambla de Ria Viuda		Spain	125G	1 056	171 000	22 700	Limestone	1921
886B	Marikanawe 1	Vedavati	Mysore	India	162G	1 330		690 000	Quartzite & Schist	1923
889	Marmore see Lago Goillet 25									
891	Maroondah 24A	Watts	Victoria	Australia	135G	936	172 000	23 000	Dacite	1926
897A	Matemale 33	Aude		France	105E	3 231	589 000	16 600	Granite	Proposed
900	Matrullas 31A	Matrullas		Puerto Rico	125E	950	496 000	3 000	Tuffaceous Shale	1948
901	Matsubagawa 29	Matsuba	Shikoku	Japan	263G	890	705 000	114 000	Sandstone	Proposed
904	Maury see Lardit 5 - 33									
905	Mauvoisin 19 - 44 - 48	Drance de Bagnes	Valais	Switzerland	776A	1 750	2 740 000	144 000	Granite	1959
906A	Mayurakshi 1	Mayurakshi	Bihar	India	155G	2 170	370 000	500 000		1955
908	McConnell see Des Joachims 15									
908A	McCormick 17	Manicouagan	Quebec	Canada	125G	4 600				1952
911A	Mechra Homadi 3 - 16A	Moulouya	Oujda	Morocco	185G	720	55 000	33 000	Marl, Limestone	1955
911B	Mechra Klila	Moulouya	Oujda	Morocco	229G	1 000	824 000	51 000	Marl, Limestone	1957
912	Medio Flumendosa see Nuraghe Arrubin 9									

913	Mediano	11 - 34	Cinca	Huesca	Spain	223G	1 407	471 000	253 000	Limestone	Under Constr.
916A	Mellah	3	Oued Mellah	Casablanca	Morocco	107G	452	32 700	14 600	Schist	1931(1940)
920A	Mercier Storage	31	Gatineau	Quebec	Canada	100G	1 200	64 600	2 150 000	Igneous Rock	1927
926	Mettur (Cauvery,Stanley)	1	Cauvery	Madras	India	231G	5 300	2 020 000	2 147 000	Rock	1934
929	Miboro	29	Sho	Hokuriku	Japan	427RF	1 450	9 200 000	321 000	Quartz Porphyry	1957
930	Mignano	9 - 25	Arda	Emilia	Italy	200G	1 120	308 000	11 500	Limestone	1935
933A	Minilla	11 - 34	Ribera de Huelva		Spain	203G	8 840	225 000	49 100		1950
934A	Miranda	49	Douro		Portugal	230G				Granite	Proposed
936	Mississagi see Geo. W. Rayner	15									
937	Mitchell	8A	Coosa	Alabama	U.S.A.	105G	1 264	202 000		Schist	1924
941A	Moell see Margaritzen	4									
944	Molare (Zerbino)	9 - 25	Orba	Piemonte	Italy	154G	478		14 600	Serpentine	1925
945	Molato (Tidone)	9 - 25 - 36	Tidone	Emilia	Italy	181MA	1 055	150 000	10 500	Conglomerate Sandstone	1928
945A	Moledana (Ratti)	25 - 30	Ratti	Sondrio	Italy	140A	211	16 700	90	Schist	1931
946	Molina	19 - 44	Calancasca	Graubunden	Switzerland	167G	252	17 600	600	Gneiss	1951
946A	Mollaro	9 - 25	Noce	Trentino - Alto Adige	Italy	125G	328	52 300	700	Limestone Marl	1929
946B	Momogatani	25 - 29	Yoshino	Shikoku	Japan	370G	920	1 150 000	160 000	Schist	Proposed
946C	Monceaux la Virole	33	Vezere		France	102A	344		15 400	Gneiss	1946
947	Moncenisio No. 1	9	Cenischia	Piemonte	Italy	110G	346	53 000	28 000	Schist	1923
947A	Moneva	11 - 34	Aguas Vivas	Zaragosa	Spain	164G	499	80 500	8 000	Conglomerate	1924
948	Monforte	49	Coa		Portugal	361A	1 700	301 300	252 500	Granite	Proposed
950	Monsalvens	Delete									
950A	Montargil	49	Sor		Portugal	115E	1 400		133 200	Diorite	Proposed
950B	Montefurada	11	Bibey		Spain	138G	476	87 500	8 500	Slate	1952
951	Montejaqne	11 - 34	Guadares	Malaga	Spain	282A	108	35 000	33 000	Limestone	1924
951A	Monte Pranu	25	Palmas	Sardegna	Italy	105G	70P	70 500	51 000	Trachyte	1951
951B	Monte Surei	9 - 25	Mulargia	Sardegna	Italy	329GA	847	300 000	246 000	Porphyritic Schist	1957
951C	Monteynard	5	Drac	Isere	France	490A	590	365 000	178 000	Limestone	Proposed
952A	Mont Larron	33	Maulde		France	105MA	567	17 000	3 800	Granite	1954
952B	Montoro	34	Montoro		Spain	124G	540		23 000		1940
952C	Montsalvens (LaJogne)	4 - 44	Jogne	Frybourg	Switzerland	186A	361	34 000	8 900	Granite	1921
953A	Mooser see Mooserboden	4									
954	Mooserboden Drossen (E)	4 - 19	Kaprun	Salzburg	Austria	368A	1 180	440 000	67 000	Mica Schist	1955
	Mooser (W)		Kaprun	Salzburg	Austria	335G	1 540	836 000	67 000	Mica Schist	1955
955	Mor	1 Delete									
956	Morasco	9 - 25	Gries	Piemonte	Italy	189G	1 850	338 000	14 200	Mica Schist	1940
962A	Motz Valde Fier	5	Le Fier	Hte Savoie	France	132G	115	31 000	4 050	Limestone	Proposed
963A	Moulinard	7 - 33	Diege	Correze	France	108G	295	30 150	5 600	Granite	1927
968	Mud Mountain (Stevens)	8A	White	Washington	U.S.A.	425ERF	700	2 230 000	130 000		1948
969	Mukurti	1	Mukurti	Madras	India	112G	530	45 000	41 000	Charnockite	1938
971	Mulshi	1		Bombay	India	166G	5 103	825 000	424 000	Deccan Trap	1929
977	Muschioso (Fontanaluccia)	9 - 25	Dolo	Emilia	Italy	144MA	426	44 500	2 200	Sandstone	1928
983	Namal	1	Sutlej	W.Punjah	Pakistan	128G	321		48 000		1913
988	Narrows (Yadkin)	2	Pee Dee	N.Carolina	U.S.A.	216G	1 150	525 000	140 000	Arkose	1917
992A	Nebeur see Oued Mellegue	24									
1004	Niedererenbach see Garichte	19 - 44									
1006	Nihotupu	45	Nihotupu		New Zealand	165E	530	71 300	2 000		1923

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH										TABLE I (CONT'D)
REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1007	Nijar 11 - 34	Carrizal		Spain	101G			1 700		18[illegible]0
1013	Nizamsagar 1	Manjira	Hyderabad	India	138G	10 330	1 135 000	596 000	Granite with Dikes	1931
1016	Non 9 Delete									
1028A	Nugu 1	Nugu	Mysore	India	143GE	1 560	G 176 600 E 270 000	125 000		1956
1029	Nukabira 29	Tekachi	Hokkaido	Japan	246G	941	588 000	154 000	Andesite	1936
1030A	Nuraghe Arrubin 9	Medio Flumendosa	Sardegna	Italy	377GA	853	400 000	258 000	Porphyry Gneiss	1958
1032A	Oberaar 44	Aare	Berne	Switzerland	328G	1 722	614 000	47 000		1953
1035A	Ocoee No. 1 (Parksville) 8A	Ocoee	Tenn.	U.S.A.	135G	840			Sandstone	1910
1036	Ocoee No. 3	Ocoee	Tenn.	U.S.A.	110G	610	80 000	14 170	Slate & Conglom.	1942
1037	Odono 29	Naka	Shikoku	Japan	195G	800	193 000	5 700	Sandstone & Slate	Proposed
1048	Oi 29	Kiso	Tokai	Japan	161G	900	150 000	69 000	Granite, Quartz Porphyry	1924
1051	Okutadami 29	Tadami	Tohoku	Japan	509G	1 410	1 970 000	544 000	Gabbro, Clay-Slate	1956
1054A	Oliana 11 - 34	Segre	Lerida	Spain	243G	745	426 000	79 500	Conglomerate	Under Constr.
1057	Omori 29	Omori	Shikoku	Japan	168G	700	90 000	5 600	Schist	Proposed
1057A	Onda 11 - 34	Veo	Castellon	Spain	118G	427	27 000	3 200	Sandstone	1950
1058	Ondenon 7 - 33	Ondenon	Loire	France	124G	420		300	Mica Schist	1904
1060	Ordunte 11 - 34	Ordunte	Burgos	Spain	161G		29 000	18 000		1933
1061A	Orichella 25	Ampollino	Catanzaro	Italy	111A	279	12 400	160	Granite	1928
1065A	Oschiri (Coghinas) 9	Coghinas	Sardegna	Italy	190G	608	144 000	255 000	Granite	1926
1066	O'Shanassy 24A	O'Shanassy	Victoria	Australia	113E	740	320 000	3 400	Dacite & Clay	192[illegible]
1070	Osiglietta 9 - 25 - 36	Osiglietta	Liguria	Italy	252A	735	98 000	10 500	Porphyry Gneiss	1939
1071	Osmansagar 1		Hyderabad	India	120GE	6 300	282 000	90 000		1920
1074A	Ottenstein 4	Kamp	Lower Austria	Austria	213A	786	170 000	40 500	Gneiss	1955
1074B	Otto Holden (LaCave) 15	Ottawa	Ontario	Canada	140G	2 570	248 600	62 000	Gneiss	1952
1075	Oued Fodda 13	Oued Fodda		Algeria	279G	594	357 000	182 000	Limestone	1932
1076	Oued Kebir 24	Oued Kebir		Tunisia	115RF			16 000	Limestone	1928
1077	Oued Ksob 13	Oued Ksob		Algeria	105HA	835	35 000	6 900	Limestone	1939
1077A	Oued Mellah see Mellah 16A									
1077B	Oued Mellegue (Nebeur) 7 - 24	Oued Mellegue		Tunisia	230HA	1 550	330 000	243 000	Marly Limestone	1954
1077C	Oule 7 - 33	Oule	Basses Pyrenees	France	106G	594	57 300	5 200	Schist, Granite	1923
1077D	Owen Falls	White Nile		Uganda	100G	2 500				1954
1085	Pack 4	Teigitsch	Styria	Austria	118G	600	50 000	4 400	Mica Schist	1932
1089A	Palagnedra 44	Melezza	Ticino	Switzerland	229G	367	86 200	3 800		1953
1090A	Palisse 30 - 33	Loire	Ardeche	France	171A	646	39 300	6 300	Granite Gneiss	1954
1090B	Palmaces 11 - 34	Canamares	Guadalajara	Spain	103G	502	55 000	25 200		1950
1092	Panchet Hill 1 - 8A	Damodar	Bihar	India	130E	17 460	6 400 000	1 210 000	Gneiss & Schist	1958
1092A	Panigai 23	Bitto di Gerola	Sondrio	Italy	136A	160	6 500	100	Mica-Gneiss	1941
1092B	Pannessiere 5 - 7 - 33	Yonne	Nievre	France	161MA	1 115	104 800	66 900	Granite	1950
1093	Pantano d'Avio 9 - 25 - 36	Avio	Lombardia	Italy	210B	1 312	249 000	10 100	Grano-Diorite	1955
1094A	Paradela 49	Cavado		Portugal	367RF	1 900	3 537 000	128 000	Granite	1956
1097	Pareloup 33	Vioulou	Aveyron	France	138A	666	45 800	137 800	Gneiss	1950
1098	Pariat 1		Madhya Pradesh	India	110E	3 875	577 000	15 000		1927
1099A	Parksville see Ocoee No. 1 8A									

1100	Pas du Riot	7 - 33	Furan	Loire	France	112G	469		1 000	Granite	1877
1103	Patillas	31A	Patillas		Puerto Rico	147E	1 020	920 000	14 500		1913
1106	Parana	9 - 25	Limentra	Emilia	Italy	171MA	592	47 000	650	Sandstone Schist	1925
1106A	Peares	11 - 34	Mino	Orenso	Spain	295G	850	523 000	145 900	Granite	1953
1108	Pego do Altar	49	Sado		Portugal	213RF	630	484 700	65 000	Schist	1949
1109	Peixoto	19	Rio Grande	Minas Gerais	Brazil	200A&G	1 300	500 000	3 250 000	Quartzite	1957
1110A	Pena	11 - 34	Gallego	Huesca	Spain	193G	600	49 500	20 300	Limestone	1913
1110B	Pena	11 - 34	Matarrana	Teruel	Spain	177G	443	47 000	17 400		1930
1111	Pend d'Oreille	31 Delete									
1112	Pensacola	19A	Grand	Oklahoma	U.S.A.	152MA	6 565	510 500	2 200 000	Limestone Chert	1940
1114	Periyar	1	Periyar	Madras	India	176G	1 241	185 000	225 300		1897
1114A	Perunchani	1	Kodyar	Travancore	India	119G	1 224	67 700	52 800		1952
1115A	Peters (Big Carson)		Lagunitas Creek	California	U.S.A.	180E	750	925 000	17 000		1953
1115B	Petite Rhue	7 - 33	Petite Rhue	Cantal	France	108G	134	9 430	300	Gneiss Granite	1926
1115C	Pfaffensprung (Amsteg)	44	Reuss	Uri	Switzerland	105A	214	2 100	160	Granite	1921
1116A	Piaganini	9 - 25 - 41	Vomano	Abruzzi	Italy	149AG	380	35 000	1 140	Marly Limestone	1954
1116B	Piano dei Greci (None)	9 - 25	Belice	Sicilia	Italy	138RF	850	236 000	26 600	Compact Clay	1924
1116C	Pian Casere see Casere	25									
1116D	Pian del Barbellino see Barbellino	25									
1117	Piano dei Greci	Delete									
1118	Piano del Leone (San Cristoforo)	9 - 25	San Cristoforo	Sicilia	Italy	113G	355	32 800	3 400	Marly Limestone	1933
1119	Pian Palu	9 - 25	Noce di Val di Monte	Trento	Italy	164RF	574	198 000	12 600	Gneiss Quartz	1955
1119A	Pian Telessio	3 - 25	Piantonetto	Piemonte	Italy	263A	1 692	497 000	19 400	Gneiss	1957
1119B	Picadas	11 - 30	Alberche		Spain	179G	459	104 000	12 400	Granite	1951
1120	Pickwick Landing	8A	Tennessee	Tennessee	U.S.A.	113EG	7 715	3 596 000	418 000	Limestone, Sandstone, Shale	1938
1120A	Picote	49	Douro		Portugal	328A	390	301 300		Granite	1957
1120B	Pidima	27	Ladhon	Peloponnesus	Greece	180B	335	43 000	40 000	Limestone	1954
1121	Pieve di Cadore	9 - 25	Piave	Belluno	Italy	368AG	1 345	494 000	55 600	Dolomite	1950
1125	Pine Portage	15	Nipigon	Ontario	Canada	150G	3 106	299 400	11 136 000	Granite Gneiss	1950
1126	Pinet	33	Tarn	Aveyron	France	118G	574	117 900	10 900	Gneiss, Mica-Schist	1929
1126A	Pine Tier	32	Nive	Tasmania	Australia	120G	627	97 000			1953
1127A	Pintado	11 - 34	Viar	Sevilla	Spain	267G	973	374 000	163 700		1950
1129	Pipri (Rihand)	1 - 47	Rihand	Uttar Pradesh	India	296GE	3 142	2 190 000 Conc. 2 990 000 Earth	8 600 000	Phyllite, Gneiss, Granite	Proposed
1130A	Pit River No. 7		Pit	California	U.S.A.	180G	580				Proposed
1131	Pittsburgh	8A	Connecticut	N.H.	U.S.A.	100E	2 200			Glacial Deposits	1941
1131A	Platani (Fanaco)	9 - 25	Platani	Sicilia	Italy	217RF	722	288 000	15 400	Limestone Clay	1955
1133	Poglia (Sonico Cedegolo)	9 - 25	Poglia	Lombardia	Italy	161B	450	45 000	400	Gneiss Schist	1950
1136	Pont de Salars	33	Viaur	Aveyron	France	11PA	656	42 300	16 200	Mica Schist	1951
1136A	Pont du Loup		Drac	Htes Alpes	France	157G				Mica Schist	1922
1137	Ponte Alto	9 - 25	Fersina	Trento	Italy	124A	43	1 700	Silted	Limestone	1611(1887)
1137A	Pontecosi	25	Serchio	Lucca	Italy	100G	458	32 600	2 400	Sandstone	1925
1137B	Ponte della Serra (Cismon)	9 - 25	Cismon	Veneto	Italy	128A	148	26 000	3 200	Limestone	1910
1137C	Ponte Fiume	9 - 25	Liri	Lazio	Italy	102G	148	26 000	2 750	Sandstone Schist	1925
1137D	Ponte Racli	25	Meduna	Udine	Italy	209A	391	23 500	20 300	Limestone	1951
1137E	Pontesei	9	Mae	Veneto	Italy	305A	492	72 000	8 300	Dolomite	1957
1137F	Ponte Vittorio	9	Strona di Cossato	Piemonte	Italy	125B	425	32 000	430	Diorite	1956
1138	Poolburn	45	Poolburn	Otago	New Zealand	114A	535	14 000	21 000	Schist	1931
1139	Poona (Lake Fife)	1 - 30	Khadakwasla	Bombay	India	130G	4 827	386 000	70 960	Hard Rock	1879

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1141	Portefiume 9 Delete									
1143	Posticciola (Turano) 9	Turano	Lazio	Italy	245G	840	374 000	132 000	Limestone	1939
1143A	Potrero de los Funes 10	Las Chacras	San Luis	Argentina	108A	131	2 900	9 700		1927
1146A	Povoa 49	Niza		Portugal	105G	1 310	41 900	17 900	Shale	1932
1146B	Pozzillo 9	Salzo	Sicilia	Italy	179RF	817	438 000	107 000	Sandstone Marl	1957
1147	Pracana 49	Ocreza		Portugal	213B	840	170 300	81 200	Shale	1951
1147A	Prada 11	Jares		Spain	259B	879		101 400	Granite	Proposed
1147B	Pra da Stua 9 - 25	Aviana	Trentino - Alto Adige	Italy	141AG	285	39 300	1 300	Limestone	1952
1149	Pragneres see Cap de Long 7 - 33									
1153	Pretty Valley 22	Kiewa	Victoria	Australia	211MA	1 250	200 000	162 000		Proposed
1157	Prizzi 9 - 25	Raia	Sicilia	Italy	148G	491	92 000	7 050	Limestone	1943
1159	Provvidenza 9 - 25 - 41	Vomano	Abruzzi	Italy	168A	525	51 000	1 940	Sandstone Shale	1947
1159A	Publino 25	Livrio	Sondrio	Italy	138AG	674	44 400	4 100	Gneiss	1951
1161	Puentes 11 - 34	Guadalentin	Murcia	Spain	237G	926	102 000	17 900		1884
1161A	Puentes Viejas 11 - 30 - 34	Lozoya	Madrid	Spain	208G	932	194 000	46 200		1884
1162	Pukaki 45	Pukaki	Canterbury	New Zealand	100E	2 000	350 000	735 000	Moraine	1951
1164	Punta Negra 10 Delete									
1164A	Puyvalador 7 - 33	Aude	E.Pyrenees	France	121G	525	47 100	8 100	Schist	1932
1165	Pyhakoski 46	Oulojoki		Finland	148G		190 000		Granite	1948
1165A	Pykara 1	Pykara	Madras	India	177G	601	148 000	47 000		1945
1170A	Quebradona 30		Antioquia	Colombia	160E	650	680 000	5 700	Decomposed Granite	1957
1172A	Quipar 11 - 34	Quipar	Murcia	Spain	157G	295	44 500	29 500		1905
1173	Rabiusa see Eggschi 44									
1174	Radhanagari 1		Bombay	India	140G	3 750	480 000	137 000	Deccan Trap	1951
1175	Raeterischboden 19 - 44	Aare	Berne	Switzerland	302G	1 500	366 000	21 900	Gneiss	1950
1178	Ramapadasagar 1 - 47	Godaveri	Madras	India	428G	7 000	8 000 000	15 600 000	Rock	Proposed
1178A	Rangwan 1	Banne Nadi	Uttar Pradesh	India	100E	1 900		133 000	Quartzite & Shale	1953
1178B	Ranna 4	Ranna	Upper Austria	Austria	151A	420	38 000	1 800	Gneiss Granite	1950
1180	Rapide Blanc 8A	St. Maurice	Quebec	Canada	150G				Granite Gneiss	1932
1180A	Rassisse 7	Dadou	Tarn	France	105A			10 500	Schist	1954
1181A	Raviege 33	Raviege		France	115B	610	49 800	36 500	Granite	Proposed
1185A	Regua 49	Douro		Portugal	108G				Shale	Proposed
1186A	Relleu 11 - 30	Relleu		Spain	105A	505		500		1500
1187	Rempen 19 - 44	Wagitaler - Aa	Schwyz	Switzerland	103G	422	28 200	290	Gneiss	1924
1189	Requejada 11 - 34	Pisuerga	Valencia	Spain	194G	719	131 000	53 100	Conglomerate	1935
1189A	Retuerta 11 - 30	Arlanza		Spain	182G	720	130 000	94 900	Conglomerate	Proposed
1190	Riband Delete									
1192	Ricobayo (Esla) 11	Esla	Zamora	Spain	326G	791	497 000	960 300	Granite	1935
1193A	Rihand see Pipri 47									
1193B	Rimasco 25	Sermenza	Vercelli	Italy	100A					1925
1196A	Rio Frio 11 - 30	Moros		Spain	131B	689	52 000	2 000	Granite	1950
1196B	Rio Fucino (Campotosto) 25- 41	Vomano	Abruzzi	Italy	118G	384	48 100	124 000	Limestone, Sand, Clay	1951
1197	Rio Grande de Loiza 31A	Rio Grande de Loiza		Puerto Rico	100G	700	67 000	20 000	Andesite	1951

1198A	Riosequillo	11 - 30	Lozoya		Spain	161G	3 609	390 000	40 500	Granite	1951
1198B	Rio Tercero	10	Tercero	Cordoba	Argentina	177RF	410	392 400	454 000		1931
1199	Ripa •	9 - 25 Delete									
1199A	Riudecanas	11 - 30 - 34	Riudecanas		Spain	116G	722	390 000	2 400		1916
1199B	Rive sur le Ban see Ban	33									
1200	Rocchetta	9 - 25 - 36	Teglia	Toscana	Italy	249A	448	64 000	4 000	Sandstone	1937
1200A	Rochebut (Cher)	5 - 33	Cher	Allier	France	180G	320	86 400	21 000	Granite	1908
1200B	Roche le Peyroux	7	Diege	Savoie	France	131G	295	43 000	6 500	Granite	1927
1201	Rochemolles	9 - 25	Rochemolles	Piemonte	Italy	193G	854	214 000	2 760	Limestone Schist	1929
1205	Rocky Valley	22	Kiewa	Victoria	Australia	100ERF	1 700	630 000	22 000		1957
1207A	Roseiras		Nile		Sudan	170G	2 200				Proposed
1208	Roseland (Bathie)	5 - 33	Doron de Roseland	Savoie	France	492AB	2 500	1 572 000	194 600	Gneiss	Proposed
1210	Rossens	19 - 44	Saane	Fribourg	Switzerland	272A	1 050	326 000	146 000	Gneiss	1948
1213	Roxburgh	45	Clutha	Otago	New Zealand	240G	1 200	350 000	1 940 000	Schist	1955
1216	Rumblar	11 - 34	Rumblar	Jaen	Spain	213G	722	216 000	102 000		1935
1221	Sabbione	9 - 25	Sabbione	Piemonte	Italy	200B	915	177 000	21 000	Limestone & Schist	1954
1227A	Saint Chamond	7	Gier	Loire	France	147A	670	26 000	1 600	Mica Schist	1953
1227B	Saint Ferreol	7 - 33	Landot	Hte Garonne	France	118E	2 558		5 100	Granite & Clay	1680
1228	Saint Mark	7 - 33	Taurion	Hte Vienne	France	134G	544	98 200	16 200	Gneiss	1930
1229	Saint Peyres	5 - 33	Arn	Pyrenees	France	197G	604	157 200	26 400	Gneiss	1936
1229A	Saint Pierre Cognet	5 - 7 - 33	Drac	Isere	France	256A	426	55 000	23 500	Marly Limestone	Proposed
1234	Sakuma	29	Tenryu	Tokai	Japan	492G	886	1 280 000	265 000	Granite	1956
1234A	Salamonde	7 - 49	Cavado		Portugal	246A	660	121 800	50 300	Granite	1953
1235	Salanfe	19 - 44	Salanfe	Valais	Switzerland	171G	2 020	327 000	32 500	Gneiss	1953
1236	Salarno	9	Salarno	Lombardia	Italy	135G	890	90 000	14 000	Tonalite	1928
1236A	Salime	34	Navia	Oviedo	Spain	390G			226 000		1953
1240	Salto see Balze di Santa Lucia 9-25-36-41										
1242A	Salza	4	Salza	Styria	Austria	174A	394	29 000	8 500	Limestone	1948
1242B	Sambuco	44	Maggia	Ticino	Switzerland	426AG	1 116	1 050 000	50 200		1957
1243	Sameura	29	Yoshino	Shikoku	Japan	321G	1 330	1 220 000	206 000	Schist	Proposed
1248	San Antonio		Santa Ana	California	U.S.A.	160E	3 850	5 000 000			1956
1250	San Cristoforo see Piano del Leone 9										
1252	San Domenico	9 - 25	Sagittario	Abruzzi	Italy	138A	164	15 700	1 000	Limestone	1929
1252A	San Esteban	11 - 34	Sil	Orense	Spain	380A	945	599 000	172 700	Gneiss	1955
1254	San Gabriel No. 1	8A	San Gabriel	California	U.S.A.	375RF	1 670	10 260 000	44 000	Granodiorite & Gneiss	1938
1255	San Gabriel No. 2	8A	W.F. San Gabriel	California	U.S.A.	255RF	620	1 200 000	13 000	Granodiorite	1935
1256	San Giacomo di Fraele	9 - 19 - 25	Adda	Lombardia	Italy	284B	1 770	710 000	52 000	Limestone	1950
1256A	San Giuliano	25	Bradano	Matera	Italy	112G			52 700		In Constr.
1257	Sanguineto (Val Noci)	9	Noci	Liguria	Italy	190G	712	183 000	2 760	Marly Limestone	1931
1259	San Juan	11 - 30	Alberche		Spain	253G	765	262 000	120 000	Granite	1954
1267	San Pietro (Muro Lucano)	9	S. Pietro	Bosilicata	Italy	168A	180	13 000	3 800	Limestone	1917
1267A	San Pons	11 - 34	Cardoner		Spain	190G	1 118	301 000	20 300	Shale	1954
1268	San Potito	9 - 25	S. Potito	Abruzzi	Italy	100E	Dismantled since 1925			Limestone	1921
1269	San Roque	10	Primero	Cordoba	Argentina	148G	475	116 400	283 800		1944
1270	San Salvatore	9 - 25 Delete									
1270A	Santa Ana	11 - 34	Noguera Ribagorzana	Lerida	Spain	238G	784		195 400		Proposed
1271	Santa Caterina	9 - 25	Ansiei	Veneto	Italy	164G	608	17 000	5 400	Sandstone - Schist	1931

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TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1271A	Santa Chiare d'Ula (Tirso) 9 - 25	Tirso	Sardegna	Italy	230HA	855	216 000	328 000	Trachyte	1923
1272A	Santa Engracia 11 - 30 - 34	Zadorra	Alava	Spain	102B	1 520	120 000	81 100		Under Constr.
1274	Santa Giustina 9 - 19 - 25 - 36	Noce	Trentino	Italy	500A	408	147 000	147 000	Dolomite	1951
1275	Santa Luzia 7 - 49	Pampilhosa		Portugal	249A	380	104 800	40 600	Quartzite	1944
1275A	Santa Maria Belsue 11 - 30 - 34	Flumen	Huesca	Spain	171G	410	77 000	10 500	Limestone	1940
1275B	Santa Teresa 11 - 34	Tormes	Salamanca	Spain	187G	1 732	369 800	321 000	Quarzite	1955
1276	Santeetlah 2	Little Tennessee	N.Carolina	U.S.A.	212A	1 150	195 000	131 000	Arkose	1928
1276A	Sant'Eleuteria 25	Liri	Frosinone	Italy	108G	283	23 500	650	Sandstone	1928
1276B	Santolea 11 - 34	Guadalope	Teruel	Spain	171G	640	140 000	43 800		1933
1279	San Valentino 9 - 25 - 36	Adige	Trentino	Italy	113E	1 530	785 000	91 000	Alluvial	1950
1281	Sardegnana see Lago Sardegnana 9									
1283A	Sarno 7	Oued Sarno		Algeria	115E	2 000	365 000	18 000	Alluvium	1952
1284	Sarrans 5 - 7 - 33	Truyere	Aveyron	France	371G	738	589 500	235 200	Granite	1933
1286	Sarutani 29	Totsu	Kinki	Japan	233G	520	270 000	19 000	Shale	1955
1286A	Sau 11 - 34	Ter	Gerona	Spain	213G	663	212 000	94 900		Under Constr.
1286B	Saucelle 11	Duero		Spain	246A			132 200		Under Constr.
1287A	Saut du Saumon 7 - 33	Vezere	Correze	France	108G	315	26 200	250	Granite	1930
1288	Sautet 5 - 7 - 33	Drac	Isere	France	416AG	272	131 000	105 400	Limestone	1934
1294	Scais 9 - 25 - 36	Caronno	Lombardia	Italy	197B	1 310	260 000	7 300	Quartz Gneiss	1940
1294A	Scalere (Brasimone) 9 - 25	Brasimone	Emilia	Italy	116G	557	52 500	5 700	Sandstone	[illegible]
1295	Scandarella 9 - 25	Tronto	Abruzzi	Italy	177G	673	140 000	9 600	Sandstone	1924
1298	Schollenen Canyon 19 - 44 Delete									
1299	Schrah 44	Wagitaler - Aa	Schwyz	Switzerland	362G	510	310 000	119 000	Gneiss	1925
1305A	Sebakwe 48	Sebakwe	S.Rhodesia	Africa	127B	800	60 000	128 000	Dolerite	1955
1306	Seeuferegg see Grimsel 19									
1307	Sella 19 - 44	Riale Sella	Ticino	Switzerland	118G	1 080	97 000	7 200	Gneiss	1947
1308	Selves see Lardit 7									
1309A	Senaiga 9 - 25	Senaiga	Veneto	Italy	223A	409	28 000	5 200	Dolomite	1954
1314	Serre Poncon 5 - 7 - 33	Durance	Htes Alpes	France	394E	1 968	18 340 000	973 200	Alluvium	Proposed
1314A	Serru 9 - 25	Orco	Valle di Aosta	Italy	141G	1 075	200 000	11 500	Gneiss	1951
1315	Setoishi 29 Delete									
1316	Seyhan	Seyhan		Turkey	225E	5 000				1957
1320	Shepang	Housatonic	Conn.	U.S.A.	139G					1956
1325	Shimokotori 29	Kotori	Tokai	Japan	420G	1 080	1 050 000	96 000	Gneiss Granite	1957
1326	Shing Mun see Jubilee 28									
1329	Shinjo 29	Katsura	Kinki	Japan	115G	452	74 000	4 500	Clay Slate Sandstone	1951
1332	Shirawata 1	Indrayani	Bombay	India	126G	7 600	630 000	151 000	Deccan Trap	1920
1335A	Sichar 11 - 34	Mijares	Castellon	Spain	151G	1 188	142 500	39 700		Under Constr.
1337	Silvan 24A	Olinda Creek	Victoria	Australia	142E	2 114	1 739 000	32 600	Sandstone, Siltstone, Dacite Clay	1931
1337A	Silves 49	Arade		Portugal	174E	780	917 000	21 900	Schist	1954
1337B	Silvretta 4	Ill	Vorarlberg	Austria	262G	1 410	560 000	31 000	Gneiss	1943
1339A	Sisga 30	Sisga	Cundinamarca	Colombia	170E	250	372 000	73 000	Sandstone	1952
1341	Sly Park	Sly Creek	California	U.S.A.	183A	850				1955
1346	Somerset 16	Stanley	Queensland	Australia	163G	995	269 000	724 000	Porphyrite	1942
1348	Sonico-Cedegolo see Poglia 9									

[illegible] NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH										TABLE I (CONT'D)
1351A	Sotonera 11 - 30 - 34	Soton	Huesca	Spain	127E	14 323	5 544 000	153 000	Shale	1931
1351E	Sottosella 23	Isonzo		Yuogoslavia	180A	123	31 800	7 800	Limestone	1939
1357	South Spullersee 4	Alfenz	Vorarlberg	Austria	112G	912	82 500	10 400	Marly Limestone	1925
1361	Spavinaw 19A		Oklahoma	U.S.A.	105G		120 000			1951
1362	Spencer Creek Delete									
1364	Spigno Monferrato see Lago Scuro 9									
1365	Spitallamm	Aare	Bern	Switzerland	374AG	848	445 000	81 000	Granite	1932
1366	Spluga (2 dams) 9 see Cardenello and Stuetta									
1372	St Etienne Cantales 7 - 33	Cere	Cantal	France	229AG	886	196 000	105 400	Granite	1945
1377	Stewartville 15	Madawaska	Ontario	Canada	208G	1 300	237 400	5 000	Crys. Limestone	1948
1378	St Francis 8A	St Francisquito	California	U.S.A.	205G	650	175 000	38 000	Schist & Conglomerate	1926*
1385A	Strubklamm 4	Alm	Salzburg	Austria	118G	282	12 000	2 000	Dolomite	1925
1386	Stuetta 9 - 25	Liro	Lombardia	Italy	108G	655	91 000	26 300	Sericite Gneiss	1932
1388	Sudagai	Tone	Kanto	Japan	290G	980		21 000	Granite	1955
1399A	Susqueda 11 - 30	Ter		Spain	220A	250	6 200	37 300		Under Constr.
1400	Suviana 9 - 25	Limentra	Emilia	Italy	293G	721	366 000	37 800	Sandstone	1933
1406	Syr Darya Delete									
1414	Tagokura 29	Tadami	Tohoku	Japan	477G	1 410	2 420 000	400 000	Andesite Tuff	1957
1415A	Tai Lam Chung 28	Tai Lam Chung		Hong Kong	280G	1 115	287 200	16 100	Granite	Under Constr.
1421A	Talave 11 - 30 - 34	Mundo	Albacete	Spain	151G	512	600 000	35 700		1922
1422A	Tambre (Barrie de la Maza) 11 - 30	Tambre	Coruna	Spain	157G	525	91 500	24 300	Granite	1950
1424	Tandula 1	Tandula/Sukha	Madhya Pradesh	India	107E	14 500	3 420 000	223 000	Laterite	1921
1425	Tansa 1	Tansa	Bombay	India	133G	9 183	480 000	130 000	Amygdaloid Trap Rock	[illegible]
1427	Tartano 9	Tartano	Lombardia	Italy	194G	183	50 000	1 420	Gneiss Mica-Schist	1929
1430A	Tauernmoos 4	Stubach	Salzburg	Austria	100G	623	36 500	16 600	Gneiss Granite	1929
1432A	Tech, le 33	Azun		France	105A	541	15 700	1 050	Quartzite Schist	1951
1435	Tennessee Creek 2	E.F. Tuckasegee	N.C.	U.S.A.	180ERF	810	427 000	9 250	Mica Schist	1954
1437	Ternay 7 - 33	Ternay	Ardeche	France	134G	535	51 100	1 700	Granite Gneiss	1867
1437A	Terradets 34	Noguera Pallaresa	Lerida	Spain	105G	540		27 000		1935
1440	Thambraparani 1	Thambraparani	Madras	India	215G	1 104	1 770 000	101 000	Gneisses and Charnockite	1943
1443	Thokerwadi 1	Andhra	Bombay	India	195G	1 875	278 000	295 000	Deccan Trap Rock	1922
1443A	Thorpe (Glenville) 2	W.F. Tuskagee	N.Carolina	U.S.A.	150ERF	900	1 060 000	71 000	Arkose	1941
1443B	Thuries 7 - 33	Viaur	Tarn	France	105G	348	55 000	800	Mica Shist	1921
1444A	Tibi see Alicante 11									
1445	Tidoncello 9 - 25 Delete									
1450	Tignes 7 - 33 - 5	Isere	Savoie	France	590A	1 246	851 500	192 200	Quartzite	1953
1451	Tilaiya 1 - 8A	Barakar	Bihar	India	120G	1 156	200 000	320 000	Schist & Quartzite	1953
1452	Tingambato Delete									
1452A	Tinaroo Falls 16	Barren	Queensland	Australia	147G	1 800	350 000	330 000	Granite	1959
1454	Tirso see Santa Chiara d'Ula 9									
1454A	Tistino 25	Lima	Pistoia	Italy	105G	365	19 600	320	Sandstone Marl	1928
1456	Toba 11 - 34	Jucar	Cuenca	Spain	108G	1 870	196 000	32 000		1935
1457A	Toggia see Fisch 25									
1458	Tokomaru 45	Tokomaru		New Zealand	102G	430	22 000	800	Sandstone	1924

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1459	Tonoyama 29	Hiki	Kinki	Japan	184A	400	54 000	12 000		1955
1461A	Torcas 11 - 30 - 34	Huerva	Zaragoza	Spain	100G	333	28 000	7 200		1935
1461B	Torina 11 - 30 - 34	Torina	Santander	Spain	138G	449	69 000	9 700		1935
1462	Torre see Di Crosis 9 - 25									
1463A	Tovar 11	Tovar		Spain	112G	705		700		1940
1466	Tranco de Beas 11 - 34	Guadalquivir	Jaen	Spain	305G	934	301 000	405 900	Limestone	1936
1466A	Tranquera 11	Piedra		Spain	146G	733		65 700		Under Constr.
1466B	Travers 31	Bow	Alberta	Canada	155E	3 000		265 000		1954
1467	Tremp 11 - 34	Noguera Pallaresa	Lerida	Spain	341G	666	331 000	188 000		1920
1467A	Trenche 8A - 26	St. Maurice	Quebec	Canada	220G	420	243 000	257 000	Precambrian Granite Gneiss	1950
1468A	Trepido (Ampollino) 9 - 25	Ampollino	Calabria	Italy	115G	344	65 000	54 300	Granite	192?
1470	Trona 9	Lake Trona	Lombardia	Italy	196B	595	109 000	4 400	Verrucano	1942
1475	Tumut Pond 47		NSW	Australia	300A		193 000			Proposed
1476	Tungabhdra 1	Tungabhdra	Madras & Hyderabad	India	160G	6 000	3 600 000	2 600 000	Schist	1953
1479	Turano see Posticciola 9-25-36-41									
1480	Turrite see Gangheri 9									
1481	Turrite Cava 9 - 25	Turrite Cava	Toscana	Italy	117G	276	39 000	1 100	Limestone	1942
1485A	Tytam 28	Tytam		Hong Kong	130G	480	25 900	1 332		1883
1486	Tytam-Tuk 28	Tytam		Hong Kong	161G	1 255	129 000	5 180		1917
1491A	Ulldecona 11 - 34	Benifazar	Castellon	Spain	193G	591	135 000	11 400		1951
1491B	Ullivarri (Zadorra) 11	Zadorra	Alava	Spain	118B	1 476	120 000	81 100		Under Constr.
1495	Union Falls 8A	Saco	Maine	U.S.A.	140GE	500	60 000		Granite Schist Clay	1949
1501	Upper Yarra 24A	Yarra	Victoria	Australia	293ERF	2 000	7 430 000	160 000	Sandstone & Siltstone	Under Constr.
1507A	Vadiello 11	Guatizalemo		Spain	236G	459		11 600	Conglomerate	Under Constr.
1508	Vado 11 - 34	Jarama	Guadalajara	Spain	200G	518	354 000	46 500		1950
1509	Vagli 9 - 25	Edron	Toscana	Italy	270G	335	210 000	24 300	Limestone	1947(1955)
1511	Vaitarna 1	Vaitarna	Bombay	India	261G	1 820		170 000	Basalt	1955
1512	Vajont 9-19-25-36	Vajont	Veneto	Italy	840A	644	496 000		Dolomite	Proposed
1514	Val d'Auna 9 - 25	Rio d'Auna	Trentino-Alto Adige	Italy	189AG	548	80 000	330	Dolomite	1952
1514A	Val de Fier 7 - 33	Fier	Hte Savoie	France	187G	115	31 400	4 600	Limestone	1920
1515	Vale do Gaio 49	Xarrama		Portugal	167RF	1 210	825 300	48 700	Schist	1949
1516	Val de Infierno 11 - 34	Luchena	Murchia	Spain	148G	541		16 200		1791
1516A	Valeira 49	Douro		Portugal	112G				Granite	Proposed
1516B	Valette, la see Versilhac 33									
1516C	Valette-Marcillac 33	Doustre		France	164A	659	36 600	24 300	Granite	1949
1516D	Val Gallina (was 1513) 9 - 25	Val Gallina	Veneto	Italy	226A	750	124 000	4 800	Dolomite	1952
1517	Val Noce Delete									
1518	Valla see Lago Scuro 9 - 25									
1520	Valle di Cadore 9 - 25	Boite	Veneto	Italy	201A	125	7 200	4 900	Dolomite	1951
1520A	Val Noci see Sanguineto 25									
1520B	Val Pens 9	Val Pens	Lombardia	Italy	141G	249	39 000		Limestone	1950
1521A	Valsoera 9 - 25	Valsoera	Valle di Aosta	Italy	177AG	718	54 000	6 500	Gneiss	1954
1522	Valtoggia see Fisch 9									

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE I (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1526	Vani Vilas (Vanivilassa Sagara) 1		Mysore	India	163G	1 330	283 000	689 000	Quartzite	1907
1527	Vannino 9 - 25	Vannino	Piemonte	Italy	100RF	394	118 000	8 150	Cemented Moraine	1921
1528A	Vaussaire 33	Rhue	Cantal	France	105A	377	9 200	1 100	Granite	1953
1528B	Venda Nova 7 - 49	Rabagao		Portugal	315A	790	288 200	74 700	Granite	1951
1529	Venina 9 - 25 - 36	Venina	Lombardia	Italy	147MA	575	124 000	9 200	Quartz Schist	1927
1529A	Verdiana 25	Verdiana	Pistoia	Italy	105RF			300		1939
1529B	Vermilion	Mono Creek	California	U.S.A.	160E	4 230	4 800 000	125 000		1956
1530	Vermunt 4 - 19	Ill	Vorarlberg	Austria	164G	895	186 000	4 300	Gneiss	1930
1530A	Vernago 9 - 25	Senales	Lombardia	Italy	141E	1 090	965 000	12 500	Alluvial	1956
1532	Versilhac (la Valette) 7 - 33	Lignon	Loire	France	197G&A	1 653	110 000	32 400	Granite	1949
1533A	Vezins 7	Selune	Manche	France	112MA	820		15 400	Schist	1932
1534A	Vieux Emosson 44	Nant de Dranse	Valais	Switzerland	214AG	558	91 500	9 300		1955
1535	Vigario 19	Vigario Creek	Rio de J.	Brazil	145E	585	1 000 000	27 500		1951
1536	Vigario Dike 19	Vigario Creek	Rio de J.	Brazil	145E	770	795 000			1951
1537	Vila Nova 49 Delete									
1537A	Vilar 49	Tavora		Portugal	164G	760	106 100	77 100	Granite	Proposed
1538A	Villa Chiavenna 9	Mera	Lombardia	Italy	105G	390	29 000	900	Gneiss	1949
1538B	Villalcampo 11 - 34	Duero	Zamora	Spain	141G	996	265 000	46 100	Granite	1948
1538C	Villameca 11 - 34	Tuerto	Leon	Spain	108G	621	83 000	16 200	Slate	1946
1539	Villar 11 - 34	Lozoya	Madrid	Spain	182G	349	52 500	20 400	Granite	1878
1547	Waggital see Schraeh 19									
1548	Waghad 1	Walwan	Bombay	India	105E	4 840	174 000	12 000	Trap Rock & Murrum	1911
1549	Wainganga 1 - 47	Godaveri	Madhya Pradesh	India	155E	2 300		33 300 000		1955
1550	Waitaki 45	Waitaki		New Zealand	122G	1 713	271 000	6 000	Sandstone	1934
1550A	Walawe 1			Ceylon	119E	17 290	4 370 000	250 000	Biotite Gneiss	Proposed
	Warragamba	Warragamba	NSW	Australia	420G	1 100	1 400 000	1 680 000	Sandstone	1957
1557A	Wanship	Weber	Utah	U.S.A.	156E	2 000	4 000 000			Proposed
1560	Wassen 19	Reuss	Uri	Switzerland	111G		14 000	80		1949
1564A	Weissee (North) 4	Stubach	Salzburg	Austria	121G	770	77 000	12 700	Gneiss Granite	1952
1565	Whakamaru 45 - 47	Waikato	Auckland	New Zealand	173G	900	180 000	64 300	Ignimbrite	1954
1570	Wiestal 4	Alm	Salzburg	Austria	115G	226	15 500	4 400	Dolomite	1912
1571	Wiley Aj Delete									
1578	Witznau 19	Schwarza	Baden	Germany	160G	380	82 000	1 000		1946
1580A	Wood Canyon	Copper	Alaska	U.S.A.	560E					Proposed
1584	Wyman (Bingham) RA	Kennebec	Maine	U.S.A.	120E	2 400			Schist	1930
1584A	Yadkin see Narrows 2									
1599	Yesa 11 - 34	Aragon	Huesca	Spain	233G	1 319	588 000	381 900	Marl	Under Constr.
1604A	Ysbert 11 - 30	Ysbert		Spain	197A	49	2 900	6 500		1945
1608	Yusubaragawa 29	Yusubara	Shikoku	Japan	214G	750	460 000	33 000	Sandstone	Proposed
1608A	Zadorra see Ollivarri 34									
1609	Zardezas 7 - 13	Oued Sat Saf		Algeria	115G	558		11 200	Sandstone, Marl	1948
1611A	Zervreila 44	Valserrhein	Graubunden	Switzerland	494AG	1 560	850 000	81 000		1958

ADDENDUM TO SUMMARIZED DATA ON DAMS OVER 100 FEET HIGH

TABLE 7 (CONT'D)

REF. NO.	NAME	RIVER	STATE	COUNTRY	HEIGHT & TYPE	LENGTH	CONTENT CU. YD.	ACRE-FEET	FOUNDATION	YEAR COMPLETED
1612	Zezere see Castelo do Bode									
1612A	Zeuzier 44	Lienne	Valais	Switzerland	524A	870	418 000	40 500		1957
1614A	Zinn 4	Weissenbach	Carinthia	Austria	100A	250	10 500	900	Serpentine	1952
1615	Zola 5 - 7 - 33	Infernet	Bouches de Rhone	France	139A	216	9 800	2 000	Limestone	1854
	Mica Creek	Columbia	B C	Canada	700RF			10 500 000		Proposed
	Cleveland see Capilano									
	Orava	Biela Orava		Czechoslovak	130G	900	240 000	200 000		1950
	Liberty	N.F. Patapsco	Maryland	U.S.A.	160G	704	160 000	133 000		1953

TABLE II A

DAMS 400 FEET AND MORE IN HEIGHT

Gravity Dams		Arch Dams	Earth Dams
Ashley 440	Manora 655	Albito 410	Ambuklao 420
Bhakra 680	Mossy Rock 510	Beauregard 433	Anderson Ranch 456
Chatra 750	Nangiro 490	Bin el Ouidane 434	Glacier View 416
Crystal 595	Ogochi 490	Bridge Canyon 637	Mud Mountain 425
Clearwater 516	Okutadami 508	Cabril 443	Trinity 430
Detroit 463	Oroville 710	Canelles 495	Wood Canyon 560
Echo Park 525	O'Shaugnessy 430	Hungry Horse 546	
Feather River 710	Owyhee 417	Karadj 490	
Fontana 470	Pine Flat 440	Luniei 441	**Rock Fill Dams**
Glen Canyon 580	Ramapadasagar 428	Mauvoisin 776	
Grandas de Salime 441	Sakuma 492	Monteynard 490	Miboro 427
Grand Coulee 550	Shasta 602	Roselend 492	Mica Creek 700
Grand Dixence 580	Shimokotori 420	Ross 540	
Grand Dixence (2nd stage) 921	Tagokura 477	Sambuco 426	
Hoover 726	Warragamba 420	Santa Giustina 500	
Iznagar 410	Yangtze 730	Sautet 416	
Kaikawaguchi 412	Yarmuk 400	Tignes 590	
Kurobe No. 4 590	Derbendi Khan 400	Vajont 840	
Libby 410		Zervreila 494	
		Zeuzier 524	

Note: Underlining indicates "proposed".

TABLE II B

DAMS 300 TO 399 FEET HIGH

Gravity Dams

Arigine 350
Arrowrock 348
Balze di Santa Lucia 341
Belezar 328
Bluff 315
Camarasa 338
Chambon 367
Clearwater 516
Contreras 325
Curecanti 360
Deai 390
Elephant Butte 306
El Fuerte 300
Escales 394
Exchequer 326
Friant 320
Fujinose 396
Generalisimo 340
Genissiat 341
Hiwassee 307
Ikari 354
Ikawa 325
Kamikotori 344
Kariba Gorge 300
Koyna 300
Kawamata 369
Kemer 358
Kensico 307
Lower Oued Djendjen 328
Marble Canyon 300
Momogatami 370
Monte Surei 329
Mooser 335
Morris 328
Muraghe Arrubiu 377
Oberaar 328
Pardee 345
Peter Green 316
Raeterischboden 302
Rapel 328
Ricobayo 326
Sadd-el-Aali 350
Sakarya 360
Salime 390
Sameura 321
Sariyar 360
Sarrans 371
Schraeh 362
Shima 328
South Boulder Creek Canyon 340
Suiho 350
Sultan No. 1 310
Ta Fung Man 300
Tranco de Beas 305
Tremp 341
Uchikawa 390
Yakuwa 394

Arch Dams

Aldeadavila 387
Alder 330
Ariel 313
Bao 331
Bort 393
Capilano 325
Castelo do Bode 377
Castillon 328
Cohilla 381
Diablo 389
Digue la Vina 344
Forte Buso 361
Spitallamm 374
Horse Mesa 305
Kamiitsuka 311
Kamishiiba 366
La Vinia 331
Limberg 393
Margaritsen-Moell 302
Monforte 361
Mooserboden-Droosen 368
Pacoima 380
Parker 320
L'Aigle 312
Laranjeiras 361
Picote 328
Pieve di Cadore 368
Pontesei 305
San Esteban 380
Shoshone 328
Spitallamm 374
Sultan No. 2 300
Topa Topa 300
Tumut Pond 300
Venda Nova 315
Yagisawa 375

Buttress Dams

Ancipa 305

Earth Dams

Adaminaby 390
Cardenas 302
Cherry Valley 325
Kajakai 321
Lucky Peak 328
Navajo 335
Serre Poncon 394
Watauga 320
Yale 323

Rock Fill Dams

Brownlee 370
Cougar Creek 335
Goscheneralp 393
Hells Canyon 320
Kenney 317
Malpaso 360
Oshebara 312
Paradela 367
Salt Springs 328
San Gabriel No. 1 375
Green Peter 370

Note: Underlining indicates "proposed".

TABLE III
SUMMARY OF GRAVITY DAMS BUILT PER DECADE

Period	Height in Feet				Totals	
	100-199	200-299	300-399	400 & over	Per Decade	Cumulative
Before 1850	2					2
1850-59	2				2	4
1860-69	2				2	6
1870-79	7				7	13
1880-89	9	2			11	24
1890-99	14				14	38
1900-09	35	3			38	76
1910-19	41	11	3		55	131
1920-29	121	18	5	1	145	276
1930-39	98	36	6	2	142	418
1940-49	85	16	7	3	111	529
1950-	151	88	17	12	268	797
Totals	567	174	38	18		
Proposed	53	40	19	18		
Grand Totals	620	214	57	36		927

TABLE IV
SUMMARY OF ARCH DAMS BUILT PER DECADE

Period	Height in Feet				Totals	
	100-199	200-299	300-399	400 & over	Per Decade	Cumulative
Before 1850	2					2
1850-59	1				1	3
1860-69						3
1870-79						3
1880-89						3
1890-99						3
1900-09	2	1			3	6
1910-19	15	2	1		18	24
1920-29	38	11	2		51	75
1930-39	21	10	5	1	37	112
1940-49	27	8	5	3	43	155
1950-	30	32	16	12	90	245
Totals	136	64	29	16		
Proposed	4	7	7	4		
Grand Totals	140	71	36	20		267

TABLE V
SUMMARY OF MULTIPLE ARCH DAMS BUILT PER DECADE

Period	Height in Feet		Totals	
	100-199	200-299	Per Decade	Cumulative
1890-99	1		1	1
1900-09				1
1910-19	4		4	5
1920-29	17	3	20	25
1930-39	5	1	6	31
1940-49	6		6	37
1950-	1	2	3	40
Totals	34	6		
Proposed		1		
Grand Totals	34	7		41

TABLE VI
SUMMARY OF BUTTRESS DAMS BUILT PER DECADE

Period	Height in Feet			Totals	
	100-199	200-299	300-399	Per Decade	Cumulative
1910-19	5			5	5
1920-29	2			2	7
1930-39	3	2		5	12
1940-49	8	2		10	22
1950-	16	9	1	26	48
Totals	34	13	1		
Proposed	5	1			
Grand Totals	39	14	1		54

TABLE VII
SUMMARY OF ROCK-FILL DAMS BUILT PER DECADE

Period	Height in Feet				Totals	
	100-199	200-299	300-399	400 & over	Per Decade	Cumulative
1850-59	2				2	2
1860-69						2
1870-79	1				1	3
1880-89	1				1	4
1890-99	1				1	5
1900-09	1	1			2	7
1910-19	5				5	12
1920-29	9	3			12	24
1930-39	13	4	3		20	44
1940-49	3	4			7	51
1950-	8	8	2	1	19	70
Totals	44	20	5	1		
Proposed	2	6	6	1		
Grand Totals	46	26	11	2		85

TABLE VIII
SUMMARY OF EARTH-FILL DAMS BUILT PER DECADE

Period	Height in Feet				Totals	
	100-199	200-299	300-399	400 & over	Per Decade	Cumulative
Before 1850	2					2
1850-59						2
1860-69	3				3	5
1870-79	2				2	7
1880-89						7
1890-99	2				2	9
1900-09	12				12	21
1910-19	26				26	47
1920-29	58	3			61	108
1930-39	59	9			68	176
1940-49	47	9	2	2	60	236
1950-	88	30	4	1	123	359
Totals	299	51	6	3		
Proposed	19	5	3	3		
Grand Totals	318	56	9	6		389

TABLE IX
SUMMARY OF DAMS OF ALL TYPES BUILT PER DECADE

Period	Height in Feet				Totals	
	100-199	200-299	300-399	400 & over	Per Decade	Cumulative
Before 1850	6					6
1850-59	5				5	11
1860-69	5				5	16
1870-79	10				10	26
1880-89	10	2			12	38
1890-99	18				18	56
1900-09	50	5			55	111
1910-19	96	13	4		113	224
1920-29	245	38	7	1	291	515
1930-39	199	62	14	3	278	793
1940-49	176	39	14	8	237	1,030
1950-	294	169	40	26	529	1,559
Totals	1,114	328	79	37		
Proposed	83	60	35	26		
Grand Totals	1,197	388	114	63		1,763

TABLE I

COUNTRIES OR REGIONS HAVING MORE THAN TEN ENTRIES IN TABLE I

Country or Region	Approx Area Sq Miles	Entries (1)	Sq Miles Per Dam, Avg	Types of Dam G	E	A	RF	B	MA
Algeria	847,000	18	47,000	9	3	2	3		1
Argentina	1,080,000	10	108,000	1		4	2	3	
Australia	2,974,000	53	56,000	27	18	4	1	2	1
Austria	32,400	21	1,500	11		10			
Brit Isles (2)	121,000	31	3,900	18	9			4	
Canada (3)	3,690,000	47	78,000	31	7	2	4	1	2
Chile	286,000	11	26,000	1	3		7		
France	213,000	96-1/2	2,200	49	3	39-1/2		1	4
Germany	143,000	38	3,800	29	7	1	1		
India etc (4)	1,852,000	70	26,400	46	24				
Italy	120,000	164	740	84	3	48	9	14	6
Japan	148,000	222	670	185	20	10	5	1	1
Mexico	764,000	32-1/2	23,500	7	14-1/2	3	4	2	2
New Zealand	104,000	19	5,500	8	3	7	1		
Portugal	35,000	31	1,100	9	4	14	3	1	
Puerto Rico	3,400	14	240	6	5		1	2	
S Africa etc (5)	912,000	25	36,500	15	1	4	3	1	1
Spain	195,000	141	1,400	120	2	12	1	6	
Switzerland	16,000	32-1/2	490	16	1	11-1/2	1	3	
USA (6)	3,022,000	569-1/2	5,300	196	225-1/2	87	35	7	19
Other countries		117		59	36	8	4	6	4
Totals		1,763		927	389	267	85	54	41

Notes:
(1) Including proposed dams
(2) Including Channel Islands
(3) Including Newfoundland and Labrador
(4) India, Pakistan, Afghanistan, Ceylon
(5) S Africa, S and N Rhodesia
(6) Including Alaska. Dams occuring on a national boundry have been counted half to each country.

Discussion of
"RECENT TRENDS IN HYDRAULIC GATE DESIGN"

by D. A. Buzzell
(Proc. Sep. 517)

G. R. LATHAM,[1] A.M. ASCE.—Design of hydraulic gates is quite a specialized field engaging relatively few engineers. Fewer still have available the experience gained by the actual operation of the equipment. Interchange of this information is meager and Mr. Buzzell's interesting article is valuable and very welcome.

The Corps of Engineers' Nationwide survey of hydraulic gates mentioned evidently was a very thorough under-taking, and was only practical by a government agency. Undoubtedly much valuable information was obtained and it is regretted that it could not be made available to interested engineers. Many designers are not fully aware of the objections to various types of gates and why some have fallen into dis-use. The manuals by the Bureau of Reclamation have proven very valuable and are referred to by many gate designers. The writer appreciates this opportunity to learn of the large number of special gates as described by Mr. Buzzell.

The following experience may be of interest:

On several projects with which the writer was associated, sliding flat steel gates without wheels were used for closing off diversion tunnels which by-passed the stream flow during the construction of the dam. These gates are designed for the full reservoir head but are closed during the low flow period and then a permanent concrete plug is constructed in the tunnel. These gates are usually closed by burning through the supporting hanger and allowing the gate to drop freely. This method has been used successfully for gates up to 16 ft. wide by 23 ft. high.

A recent large project required three diversion gates, each approximately 18 ft. wide by 36 ft. high. They were to be designed for a full reservoir head of 180 ft. and were intended to be closed under a probable head of 50 ft. Each gate was about 50 tons, and the impact from dropping a gate of this size would be excessive. It was therefore decided to lower the gate by utilizing the intake gate hoists. The gates were equipped with rubber "J" seals and bushed wheels on cantilever axles. The gate body was designed to withstand the reservoir head of 180 ft. The wheel assemblies were designed to withstand only the closing head of 50 ft. under normal working stresses. After closure, the reservoir filling would increase the pressure on the gate and deflect the cantilever axles by 1/8" until solid blocks on the gate would come in contact with the steel guides, giving solid bearing from gate to guides to withstand the pressure from the full reservoir. This method permitted a very considerable saving in the design of the wheel assemblies.

W. G. H. HOLT.[2]—It is stated in the introduction that as late as 1946, it

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2. Mechanical Engr., Eastern Div., Dominion Bridge Co., Ltd., Lachine, Quebec, Canada.

was believed that no greater depth of water than 25 feet could be discharged over an ogee spillway without shaking the structure to pieces.

In Canada, as long ago as 1923, vertical lift spillway gates of the Stoney type as large as 50 feet wide x 30 feet high were in regular use. The Stoney design was superseded by the fixed roller construction soon after this. Many gates of the latter type of still larger dimensions have since been installed. Three 50-foot gates, 36 feet high, were installed in 1932 and are still in regular use.

These gates are operated with little or no freeboard. The great majority are exposed to severe winter conditions, some being located where temperatures drop to -50°F.

The Tainter gate has been comparatively little used in Canada. Climatic conditions are undoubtedly largely responsible for this.

The statement that, until the Randall gate was designed with a 45° sloped bottom member, high head gates had been built with nearly square bottoms because of structural considerations, is rather surprising. The 45° sloping bottom has been almost universal in Canada for head and free discharge gates for over 35 years. More than six hundred of these gates have been built in this period. Normally, the skin plate is placed on the downstream side, and large vent holes are provided in the sloping bottom and in the bottom cross girder. This construction reduces vacuum effects on the bottom to the point where they have little effect on the hoisting effort with gates of normal size. Gates as wide as 45 feet and as high as 34 feet with heads up to 75 feet have presented no insuperable difficulties in design or construction. Head gates of this type are self-lowering against full turbine flow and can be raised against full head without the use of by-pass valves.

K. S. CHETTY,[3] J.M. ASCE.—This is an excellent summary of the operating experiences with high head gates, on which little data is available, and it forms a valuable contribution to the designers of control-structures. The developments in Hydraulic gate design have been necessitated in view of the high-costs of materials during the last ten years which made the cost of other conventional and satisfactory gates like Hollow-Jet valves extremely high. The developments during the last ten years may be summarized as:

1) Re-shaping of the bottom of the gate leaf to have a well-defined control point from where the high velocity jet will shoot into the conduit. In the past designs, the continuous shifting of the control point from the u/s end to d/s end of the gate leaf has resulted in the fluctuations of pressures at the bottom of the gate leaf and hence vibrations;

2) Re-shaping of the d/s of the gate slot, to minimize the disturbance due to sudden expansion of the area at the gate slot; and

3) enabling the conduit to flow only partially full, to allow sufficient air on the d/s of the gate and obviate the negative pressures.

It will be noted that the above improvements were made to the existing slide gates and fixed-wheel gates which were used as regulating sluice-gates, but developed trouble for higher heads. The use of Tainter-gates, which has given satisfactory performances and has proved to be very economical, is an improvement which had not been thought of 10 years before. It will be interesting to note that the U. S. Bureau of Reclamation has also simultaneously developed the radial gates for high heads and in Davis Dam 22' by 19' gate is installed to operate under 113 ft. head. The design has been a conventional

3. Deputy Director, Central Water & Power Comm., New Delhi, India.

one, without any provision for hydraulically actuated or pneumatic seals, or an eccentric pin. These gates have proved to be entirely satisfactory in the field. It will be useful to compare the extra cost of the arrangement of pneumatic rubber seals or an eccentric pin with that of the hoist if the seal as shown in Fig. 1 is employed.

It is generally found that the slide-gates are always arranged in tandem, so that one gate is used as a service gate and the other in front as an emergency gate. Its utility is appreciated when there are only a small number of sluices. But, if there are a greater number of sluices, it may be more economical to provide one regulating gate for each of the sluices and only one emergency gate operated by a gantry crane and capable of closing any of the sluices. Practically in all the projects, there will always be a gantry crane on the top of the Dam for a number of other purposes. The same will be used for operating the emergency gate.

It will be useful to know the design criteria for the conduit liners to determine its thickness and the length in front and downstream of gate. It is not known whether the author's cost estimate of $400 to $500 per sq. ft. is the combined cost of service and emergency gate or for each gate.

It is stated that the fixed-wheel gate arrangement has proved to be too costly because of the welded-plate gate body. In the Continent and in this country, however, welded-gate body is more economical than cast-steel gates. Hence fixed-wheel gates have found greater application than slide gates. This has been reflected in the installation of fixed-wheel gates as against slide gates for regulating purposes in these countries. Similarly for conduit liners also, structural steel plates are being preferred to cast iron or cast steel liners.

It is not known whether the arrangement as shown in Fig. 4 of the author's paper, is more economical or better from hydraulic considerations compared to arrangement shown in the writer's Fig. 2. Since the conduit d/s of the gate of Detroit Dam is designed to flow only partially fully, the gate shaft may not be subjected to any water pressure, excepting for the spray, and hence the necessity for the liners in the gate shaft is not clear.

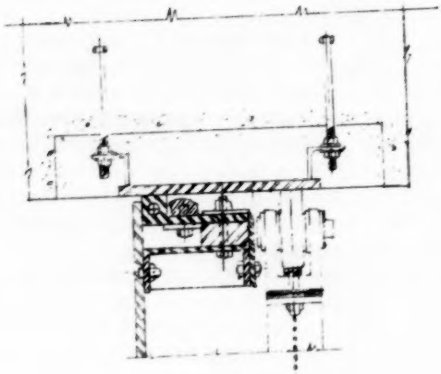
If the gate closes by its own self-weight, will a mechanical hoist with chain or rope be more economical than an hydraulic hoist?

W. G. WEBER.[4]—Mr. Buzzell's paper presents, in a carefully prepared and easily readable form, some of the more notable developments in hydraulic gate design as exemplified by the practices of the Corps of Engineers. The paper is, in the writer's opinion, of great value to engineers engaged in similar work, and especially so because of the broad field covered by Corps of Engineer projects, and the unexcelled opportunities available to its designers for preliminary model testing and for subsequent observation of the actual operating characteristics of the installed equipment. The author's comments are of especial value to organizations such as the Bureau of Reclamation's when closely parallel problems are encountered.

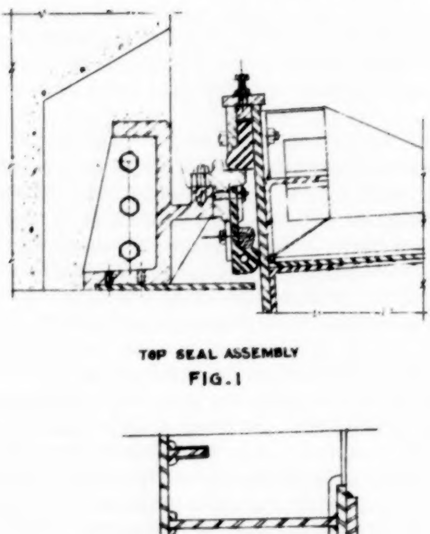
Slide Gates

The author has arrived at some conclusions with which Bureau of Reclamation engineers are quite in agreement. Thus, we have long since

4. Mechanical Engr., Bureau of Reclamation, U. S. Dept. of the Interior, Denver, Colo.

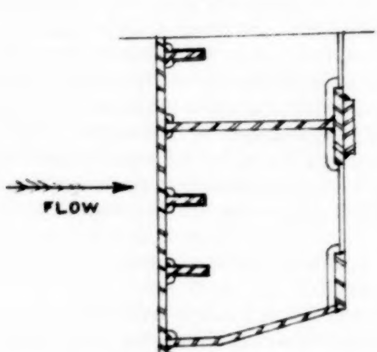


SIDE SEAL ASSEMBLY



TOP SEAL ASSEMBLY

FIG. 1



BOTTOM SHAPE OF FIXED WHEEL GATE

FIG. 2

abandoned the idea that sluice gate operations be restricted to installations where the total effective head will not exceed 100 feet.

USBR has many slide gates in many ways similar to the earlier type (illustrated as the Norfolk service gate in the author's Figure 1) in service at heads usually below 100 feet, but in some instances at heads up to 125 feet. In general, their performance has been satisfactory. However, in some installations, not necessarily the ones at higher heads, there have been indications of cavitation on the bottoms of the gate leaves and along the lower edges of the downstream gate frames. In a few of these instances cavitation has reached such an advanced stage that extensive repairs and alterations have been necessitated. The normal service gate illustrated by the author has a bottom slope of 10 to 1.5. USBR's earlier type of gate has a horizontal bottom with a slight lip at the downstream edge. Each gate has a critical percent of opening at which cavitation is most apt to occur. If operating conditions are such that a gate is not held in the critical range for appreciable periods of time it may remain in service for many years almost undamaged.

The 45° test type of design, in our belief, is a definite improvement over the older type, and our trend is toward this type of design, with the contour of the bottom of the leaf and the angularity of the faces on the sides of the downstream frames below the slots not greatly different from the ones used on the test gate and shown in part on the author's Figure 1. This trend applies not only to slide gates, but also to the larger roller- and wheel-mounted gates, such as the penstock intake gates at Grand Coulee, Hungry Horse, and Palisades dams. On the Palisades gate the bottom plate is omitted entirely but the effective slope is the same as though it were there.

The estimate that 6' x 10' is maximum size for slide gates at 200' head is questionable. The Palisades outlet gates have a greater area (67.5 square feet) and will operate under 20 percent more head. We are using a 30" cylinder and 2,000 psi design hoist. Actual operating pressure will be about 1,500 psi. As 30 inches appears to be about as large a diameter as desirable for practical use, if more operating force were required, it is probable that USBR would consider use of higher operating pressures, say, to a maximum of 5,000 psi.

USBR studies would indicate seat bearing pressures rather than hoist capacities would be the limiting considerations. We believe that bearing pressures as high as 4,000 psi would not be unreasonable if the conventional bronze on bronze seals and seats were changed to bronze on Monel or on stainless steel with lubrication grooves. The latter combination would give an added benefit as the coefficient of friction would be somewhat lower. It was proposed that this alloy combination be used on the Palisades gates but the restrictions on the use of high nickel alloys prevented consideration when final designs were prepared. In determining bearing pressures, we limit effective bearing surfaces to 4 inches preferred and 6 inches maximum transversely to the seat length, and make the gates rigid enough to avoid extreme concentration of stresses at the inner edges of the seats.

The statement that gate bodies cannot be made economically of weldments is not in agreement with USBR experience with the Shasta and Palisades outlet gates, where a combination of steel weldments and castings was used. Further, we see no reason for limiting bodies to steel and have used gray iron frequently, as in the Carter Lake (3-foot by 3-foot) outlet gates where heads of 170 feet will occur.

Tainter Gates

The use of top-seal Tainter or radial gates in conduits appears to have several desirable aspects and would bear further investigation and consideration by the Bureau. Consequently, they are greatly interested in following the service records of the gates installed by the Corps of Engineers. In particular, they are interested in the performance of the gate at Lookout Point Dam, with its eccentric trunnion and with the water passageway enlarged to provide seal mounting. USBR prefers gate water passageways with continuously uniform cross sections but they believe the Lookout Point contour can be used without detriment in many installations. The arrangement appears definitely to provide firm seating with a minimum of vibration and leakage. But unless the tendency to vibrate is pronounced, a suitable top seal and rigid hoist connection without eccentric trunnions may give equally acceptable results.

We question the use of roller bearings on the trunnions of Tainter gates, and their serviceability over an extended period of time. So far, sleeve bearings have been preferred and have given satisfactory service and shown little need for replacement when properly lubricated.

The illustration of a typical Tainter crest gate—the author's Figure 6—shows inclined arms and recessed trunnions. Gate fabrication appears more difficult than for rectangular connections. Also, the arrangement requires a relatively wide pier. Where space is at a premium and piers as narrow as practicable are desired, we question the advisability of using such a design, while admitting it has desirable features, among them being weight and cost reduction. The latter may be more apparent than real, however, if increased pier width is taken into consideration.

Roller- and Wheel-Mounted Gates

The McNary intake gate is 20 feet wide by 51 feet high with a single continuous roller train on either side of the gate. Such a train is much longer than is usually used, and since the failure of even one link in the chain would put the whole train out of service, more than normal inspection and maintenance work would seem needed. USBR has found that where feasible, wheels mounted on self-lubricating bronze bushings are preferable to roller trains from the standpoint of first cost and maintenances charges. Wheel-rail contact stresses are a limiting factor, however, and, while we have installed many wheel-mounted gates, we occasionally are faced with a load problem to which rollers appear to be the preferable solution. Normal USBR practice with either roller- or wheel-mounted gates is to suspend each from a single hydraulic hoist. Gate operation is timed for a 3-minute or shorter closing period, with the gate closing by gravity after release from its hanger. In some of the more recent USBR installations the hanger has been omitted and the gate is supported on the hydraulic fluid—usually oil—in the hoist cylinder. Cylinder pistons are packed so that downward drift is slight, and an automatic recovery system is employed to restore each gate to its fully raised position immediately above the penstock intake after a predetermined amount of drift. One advantage of this type of suspension lies in the fact that the gate may be readily lowered even in case of total power failure, whereas the latched gates require power for a brief period during which the latches are being released. Where there are a number of gates installed, a gantry crane is usually installed for maintenance work. This crane has a smaller capacity

and is much lighter than would be needed if it were required to place a gate in an emergency over the entrance to a runaway penstock.

Sleeve-Type Gates and Valves

The author quite correctly is critical of the high maintenance costs of many of the older types of cylinder gates and needle valves. We have found, however, that in some instances the causes of high maintenance costs could be removed by relatively minor design changes. There are occasional combinations of conditions that make cylinder gates look attractive in spite of a somewhat unfavorable history. USBR has not provided needle valves for outlet works for a number of years largely because, where a valve of this type is desired, a hollow-jet valve will answer the purpose at less initial expense and annual maintenance costs, even though modifications in needle valve design, as in the valves at the Madera Canal outlets of Friant Dam, have greatly improved performance records.

It is to be hoped that experiments of the type conducted by the Corps of Engineers will be continued, and that observations as to the performance of the resulting improved gates and valves will be continued for sufficiently long periods of time to establish their worth or to point to further desirable modifications.

The type of gate or valve selected for any given installation will depend, of course, not only on the initial cost of the equipment and the amount of maintenance costs and out-of-service time, but also on its functional suitability and the costs of the related structures.

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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MAY: 435(SM), 436(CP)[c], 437(HY)[c], 438(HY), 439(HY), 440(ST), 441(ST), 442(SA), 443(SA).

JUNE: 444(SM)[e], 445(SM)[e], 446(ST)[e], 447(ST)[e], 448(ST)[e], 449(ST)[e], 450(ST)[e], 451(ST)[e], 452(SA)[e], 453(SA)[e], 454(SA)[e], 455(SA)[e], 456(SM)[e].

JULY: 457(AT), 458(AT), 459(AT)[c], 460(IR), 461(IR), 462(IR), 463(IR)[c], 464(PO), 465(PO)[c].

AUGUST: 466(HY), 467(HY), 468(ST), 469(ST), 470(ST), 471(SA), 472(SA), 473(SA), 474(SA), 475(SM), 476(SM), 477(SM), 478(SM)[c], 479(HY)[c], 480(ST)[c], 481(SA)[c], 482(HY), 483(HY).

SEPTEMBER: 484(ST), 485(ST), 486(ST), 487(CP)[c], 488(ST)[c], 489(HY), 490(HY), 491(HY)[c], 492(SA), 493(SA), 494(SA), 495(SA), 496(SA), 497(SA), 498(SA), 499(HW), 500(HW), 501(HW)[c], 502(WW), 503(WW), 504(WW)[c], 505(CO), 506(CO)[c], 507(CP), 508(CP), 509(CP), 510(CP), 511(CP).

OCTOBER: 512(SM), 513(SM), 514(SM), 515(SM), 516(SM), 517(PO), 518(SM)[c], 519(IR), 520(IR), 521(IR), 522(IR)[c], 523(AT)[c], 524(SU), 525(SU)[c], 526(EM), 527(EM), 528(EM), 529(EM), 530(EM)[c], 531(EM), 532(EM)[c], 533(PO).

NOVEMBER: 534(HY), 535(HY), 536(HY), 537(HY), 538(HY)[c], 539(ST), 540(ST), 541(ST), 542(ST), 543(ST), 544(ST), 545(SA), 546(SA), 547(SA), 548(SM), 549(SM), 550(SM), 551(SM), 552(SA), 553(SM)[c], 554(SA), 555(SA), 556(SA), 557(SA).

DECEMBER: 558(ST), 559(ST), 560(ST), 561(ST), 562(ST), 563(ST)[c], 564(HY), 565(HY), 566(HY), 567(HY), 568(HY)[c], 569(SM), 570(SM), 571(SM), 572(SM)[c], 573(SM)[c], 574(SU), 575(SU), 576(SU), 577(SU), 578(HY), 579(ST), 580(SU), 581(SU), 582(Index).

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JANUARY: 583(ST), 584(ST), 585(ST), 586(ST), 587(ST), 588(ST), 589(ST)[c], 590(SA), 591(SA), 592(SA), 593(SA), 594(SA), 595(SA)[c], 596(HW), 597(HW), 598(HW)[c], 599(CP), 600(CP), 601(CP), 602(CP), 603(CP), 604(EM), 605(EM), 606(EM)[c], 607(EM).

FEBRUARY: 608(WW), 609(WW), 610(WW), 611(WW), 612(WW), 613(WW), 614(WW), 615(WW), 616(WW), 617(IR), 618(IR), 619(IR), 620(IR), 621(IR)[c], 622(IR), 623(IR), 624(HY)[c], 625(HY), 626(HY), 627(HY), 628(HY), 629(HY), 630(HY), 631(HY), 632(CO), 633(CO).

MARCH: 634(PO), 635(PO), 636(PO), 637(PO), 638(PO), 639(PO), 640(PO), 641(PO)[c], 642(SA), 643(SA), 644(SA), 645(SA), 646(SA), 647(SA)[c], 648(ST), 649(ST), 650(ST), 651(ST), 652(ST), 653(ST), 654(ST)[c], 655(SA), 656(SM)[c], 657(SM)[c], 658(SM)[c].

APRIL: 659(ST), 660(ST), 661(ST)[c], 662(ST), 663(ST), 664(ST)[c], 665(HY)[c], 666(HY), 667(HY), 668(HY), 669(HY), 670(EM), 671(EM), 672(EM), 673(EM), 674(EM), 675(EM), 676(EM), 677(EM), 678(HY).

MAY: 679(ST), 680(ST), 681(ST), 682(ST)[c], 683(ST), 684(ST), 685(SA), 686(SA), 687(SA), 688(SA), 689(SA)[c], 690(EM), 691(EM), 692(EM), 693(EM), 694(EM), 695(EM), 696(PO), 697(PO), 698(SA), 699(PO)[c], 700(PO), 701(ST)[c].

c. Discussion of several papers, grouped by Divisions.

e. Presented at the Atlantic City (N.J.) Convention in June, 1954.